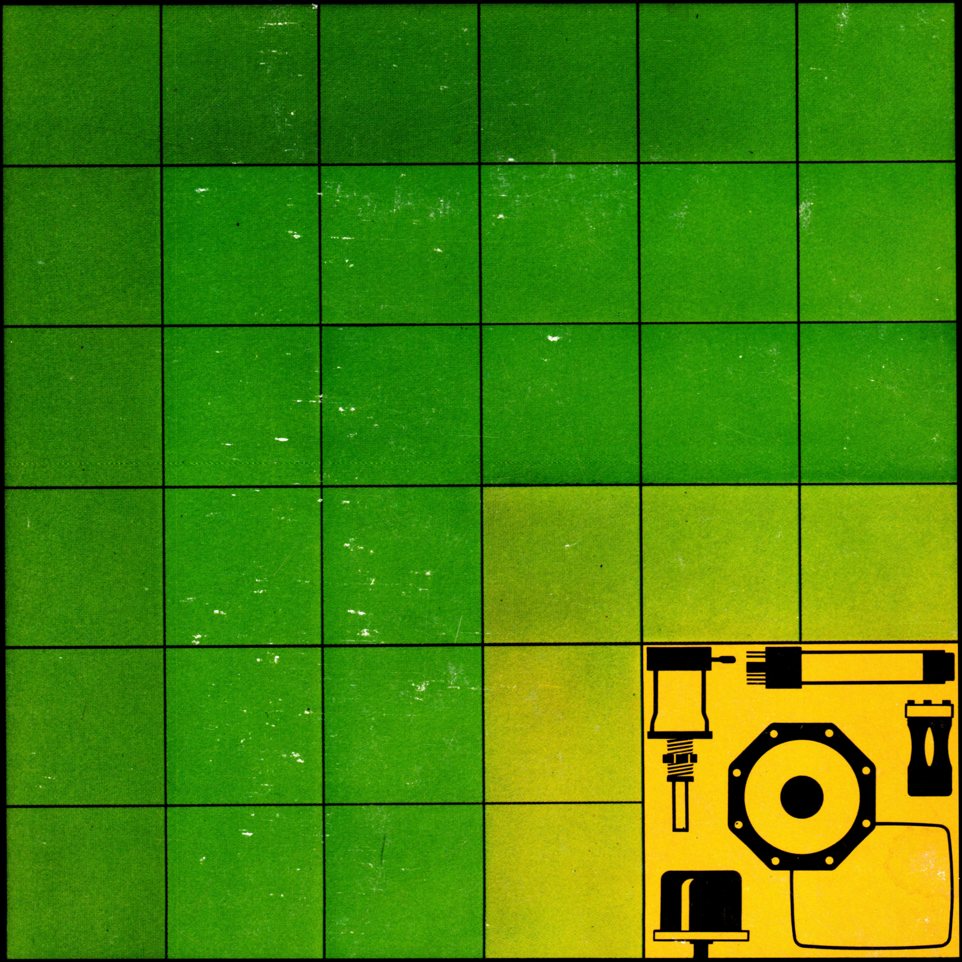
Electronic
components
and materials

PHILIPS

GENERAL CATALOGUE 1978



General catalogue 1978

semiconductors

integrated circuits,
including Signetics products

components

materials

electron tubes

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preface

This catalogue lists type numbers, catalogue numbers and brief data of the products of the Electronic components and materials division. It also includes replacement guides for electron tubes.
The semiconductor replacement guide has been removed from the catalogue. It is now available as a separate 144-page book.

Dealing as it does with so extensive a range of products, the catalogue is necessarily concise, the data it contains being in many cases too brief to support a definitive product selection. For complete data, we refer you to our system of Data Handbooks. That system, which now comprises thirty-nine volumes, is divided into three series distinguished by colour:

● **SC series**	Semiconductors and integrated circuits	**Red**
● **CM series**	Components and materials	**Green**
● **ET series**	Electron tubes	**Blue**

The contents of each volume are listed on pages VI to VIII. The catalogue section in which a product is listed also tells you the series and volume number of the Data Handbook in which you will find its complete data.

This 1978 edition of the General catalogue extends the indication of status (see page IV) to nearly all groups of products.
We welcome your suggestions for improvements that will further increase the usefulness or convenience of future editions.

Editor
February 1978

Note
Dimensions in tables and drawings are in mm, unless otherwise stated.

status guide

The status code letters used in this catalogue indicate the status of
semiconductors: at 1 October 1977
other products: at 1 January 1978

N = **New design type.** Recommended for new equipment design; production quantities available *after date of publication.*

D = **Design type.** Recommended for equipment design; production quantities available *at date of publication.*

C = **Current type.** No longer recommended for equipment design; available for equipment production and for use in existing equipment.

M = **Maintenance type.** No longer recommended for equipment production; available for maintenance of existing equipment.

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handbook survey

semiconductors and integrated circuits (red series)

Part 1a March 1976 (next issue July 1978)	SC1a 03-76	**Rectifier diodes, thyristors, triacs** Rectifier diodes, voltage regulator diodes (> 1,5 W), transient suppressor diodes, rectifier stacks, thyristors, triacs
Part 1b May 1977	SC1b 05-77	**Diodes** Small signal germanium diodes, small signal silicon diodes, special diodes, voltage regulator diodes (< 1,5 W), voltage reference diodes, tuner diodes
Part 2 November 1977	SC2 11-77	**Low-frequency and dual transistors**
Part 3 January 1978	SC3 01-78	**High-frequency, switching and field-effect transistors**
Part 4a June 1976*	SC4a 06-76	**Special semiconductors** Transmitting transistors, field-effect transistors, dual transistors, microminiature devices for thick and thin-film circuits
Part 4b July 1976 (next issue June 1978)	SC4b 07-76	**Devices for optoelectronics** Photosensitive diodes and transistors, light emitting diodes, displays, photocouplers, infrared sensitive devices, photoconductive devices
Part 5a November 1976	SC5a 11-76	**Professional analogue integrated circuits**
Part 5b March 1977	SC5b 03-77	**Consumer integrated circuits** Radio-audio, television
Part 6 October 1977	SC6 10-77	**Digital integrated circuits** LOCMOS HE4000B family
Signetics integrated circuits 1978		**Bipolar and MOS memories** **Analogue circuits** **Bipolar and MOS microprocessors** **Logic**

* Sections dual transistors and FETs have been removed to SC2 and SC3, respectively.
The remainder of Part 4a will be split as follows:

Part 4a August 1978	SC4a 08-78	**Transmitting tubes**
Part 4c May 1978	SC4c 05-78	**Microminiature devices** for thick and thin-film circuits

components and materials (green series)

Part 1 June 1977	CM1 06-77	**Assemblies for industrial use** High noise immunity logic FZ/30-series, counter modules 50-series, NORbits 60-series, 61-series, circuit blocks 90-series, circuit block CSA70(L), PLC modules, input/output devices, hybrid circuits, peripheral devices, ferrite core memory products
Part 2a October 1977	CM2a 10-77	**Resistors** Fixed resistors, variable resistors, voltage dependent resistors (VDR), light dependent resistors (LDR), negative temperature coefficient thermistors (NTC), positive temperature coefficient thermistors (PTC), test switches
Part 2b February 1978	CM2b 02-78	**Capacitors** Electrolytic and solid capacitors, film capacitors, ceramic capacitors, variable capacitors
Part 3 January 1977	CM3 01-77	**Radio, audio, television** FM tuners, loudspeakers, television tuners and aerial input assemblies, components for black and white television, components for colour television
Part 4a October 1976 (next issue July 1978)	CM4a 10-76	**Soft ferrites** Ferrites for radio, audio and television, beads and chokes, ferroxcube potcores and square cores, ferroxcube transformer cores
Part 4b December 1976	CM4b 12-76	**Piezoelectric ceramics, permanent magnet materials**
Part 5 July 1975	CM5 07-75	**Ferrite core memory products** Ferroxcube memory cores, matrix planes and stacks, core memory systems
Part 6 April 1977	CM6 04-77	**Electric motors and accessories** Small synchronous motors, stepper motors, miniature direct current motors
Part 7 September 1971	CM7 09-71	**Circuit blocks**
Part 8 February 1977	CM8 02-77	**Variable mains transformers**
Part 9 March 1976	CM9 03-76	**Piezoelectric quartz devices**
Part 10 April 1978	CM10 04-78	**Connectors**

handbook survey

electron tubes (blue series)

Part 1a December 1975	ET1a 12-75	**Transmitting tubes for communication, tubes for r.f. heating** Types PE05/25 to TBW15/25
Part 1b August 1977	ET1b 08-77	**Transmitting tubes for communication, tubes for r.f. heating, amplifier circuit assemblies**
Part 2a November 1977	ET2a 11-77	**Microwave tubes** Communication magnetrons, magnetrons for microwave heating, klystrons, travelling-wave tubes, diodes, triodes, T-R switches
Part 2b May 1978	ET2b 05-78	**Microwave semiconductor devices, isolators, circulators**
Part 3 January 1975	ET3 01-75	**Special Quality tubes, miscellaneous devices**
Part 4 March 1975	ET4 03-75	**Receiving tubes**
Part 5a March 1978	ET5a 03-78	**Cathode-ray tubes** Instrument tubes, monitor and display tubes, C.R. tubes for special applications
Part 5b May 1975	ET5b 05-75	**Camera tubes; image intensifier tubes**
Part 6 January 1977	ET6 01-77	**Products for nuclear technology** Channel electron multipliers, neutron tubes, Geiger-Mueller tubes
Part 7a March 1977	ET7a 03-77	**Gas-filled tubes** Thyratrons, industrial rectifying tubes, ignitrons, high-voltage rectifying tubes
Part 7b March 1977	ET7b 03-77	**Gas-filled tubes** Segment indicator tubes, indicator tubes, switching diodes, dry reed contact units
Part 8 May 1977	ET8 05-77	**TV picture tubes**
Part 9 March 1978	ET9 03-78	**Photomultiplier tubes; phototubes**

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letter symbols

C_d	Diode capacitance
C_{rb}	Feedback capacitance (common base)
C_{rd}	Feedback capacitance (common drain)
C_{re}	Feedback capacitance (common emitter)
C_{rs}	Feedback capacitance (common source)
CMRR	Common mode rejection ratio
D^*	Detectivity
d_{im}	Intermodulation distortion
d_{cm}	Cross-modulation distortion
$E_{e\ tr}$	Irradiance to trigger a device
F	Noise figure
f	Frequency
$f_{h_{fe}}$	Frequency at which h_{fe} is -3dB
f_T	Transition frequency
$\Delta \frac{1}{g_{fs}}$	Difference in transfer impedance
$\Delta \frac{g_{os}}{g_{fs}}$	Difference in penetration factor
G_p	Power gain
G_{UM}	Maximum unilateral power gain
h_{fe}	Small-signal current gain
h_{FE}	D.C. current gain
$\frac{\Delta I}{\Delta T}$	Equivalent differential current change with temperature
I_A	Anode current
dI_A/dt	Rate of rise of anode current
I_{ARM}	Repetitive peak anode current
I_B	D.C. (or average) base current
I_C	D.C. (or average) collector current
$I_{(CL)SM}$	Non-repetitive peak clamping current
I_{CM}	Peak value of I_C
I_D	Off-state current
I_{DSS}	Drain current (source short-circuited to gate)
I_{DSX}	Drain cut-off current (specified conditions)
I_e	Radiant intensity
I_F	Forward current (d.c. or average)
$I_{F(AV)}$	Total average forward current
I_{FM}	Peak forward current
I_{FRM}	Repetitive peak forward current
I_{FSM}	Non-repetitive peak forward current
I_{FWM}	Working peak forward current
I_{GSS}	Gate cut-off current (source short-circuited to drain)
I_{GT}	Gate-cathode current that will trigger all devices
I_H	Holding current
I_{ISM}	Non-repetitive peak input current
$I_{O(AV)}$	Average output current
I_{opt}	Output current at optimum operation
I_{ORM}	Repetitive peak output current
I_R	Reverse (cut-off) current
$I_{R(D)}$	Dark reverse current
I_{RRM}	Repetitive peak reverse current
I_{SDX}	Source cut-off current (specified conditions)
I_{SGO}	Source current (open drain)
I_T	On-state current
dI_T/dt	Rate of rise of on-state current
$I_{T(AV)}$	Average on-state current
I_{TRM}	Repetitive peak on-state current
$I_{T(RMS)}$	R.M.S. value of the on-state current
I_{TSM}	Non-repetitive peak on-state current
I_{TWM}	Working peak on-state current
I_v	Luminous intensity
I_Z	Working current (d.c. or average)
I_{ZM}	Peak working current
I_{ZRM}	Repetitive peak working current
I^2t	I squared t for fusing
N	Light sensitivity
P_D	Drive power
P.E.P.	Peak envelope power
P_L	Load power
P_o	Output power
P_{opt}	Optimum output power
P_{RRM}	Repetitive peak reverse power dissipation
P_{RSM}	Non-repetitive peak reverse power dissipation
P_S	Source power
P_{tot}	Total power dissipation
P_{ZRM}	Repetitive peak reverse power dissipation
P_{ZSM}	Non-repetitive peak reverse power dissipation
r_D	Diode series resistance
r_{diff}	Differential resistance
r_{do}	Initial dark resistance
r_{DSoff}	Drain-source resistance (off)
$r_{ds\ on}$	Drain-source resistance (on) at specified frequency
R_L	Load resistance
r_{lo}	Initial illumination resistance
S_F, S_Z	Temperature coefficient of the working voltage
T_{amb}	Ambient temperature
T_c	Colour temperature
t_d	Forward conduction delay
t_f	Fall time
T_h	Heatsink temperature
T_j	Junction temperature
T_{mb}	Mounting base temperature
t_{off}	Turn-off time
t_{on}	Turn-on time
t_q	Circuit commutated turn-off time
t_r	Rise time
t_{rr}	Reverse recovery time
t_{tot}	Total recovery time
V_{AK}	Anode-cathode voltage
V_B	Supply voltage
V_{CBO}	Collector-base voltage (open emitter)
V_{CEO}	Collector-emitter voltage (open base)
V_{CER}	Collector-emitter voltage with a specified resistance between emitter and base
V_{CERM}	Peak value of V_{CER}
V_{CES}	Collector-emitter voltage (emitter to base)
V_{CESM}	Peak value of V_{CES}
V_{CEsat}	Collector-emitter saturation voltage
$V_{(CL)R}$	Output clamping voltage
dV_{com}/dt	Rate of rise of commutating voltage that will not trigger any device
V_D	Continuous off-state voltage
dV_D/dt	Rate of rise of off-state voltage
V_{DB}	Drain-substrate voltage
V_{DRM}	Repetitive peak off-state voltage
V_{DS}	Drain-source voltage
V_{DWM}	Crest working off-state voltage
V_F	Continuous forward voltage
V_{GA}	Anode gate-anode voltage
V_{GK}	Cathode gate-cathode voltage
ΔV_{GS}	Gate-source voltage difference
$\frac{d\Delta V_{GS}}{dT}$	Thermal drift of gate-source voltage difference
V_{GT}	Gate-cathode voltage that will trigger all devices
V_I	Input stand-off voltage (transient suppressors)
V_{IRM}	Repetitive peak input voltage
$V_{I(RMS)}$	R.M.S. value of the input voltage
V_{IWM}	Crest working input voltage
V_n	Equivalent noise voltage
V_O	Output voltage
$V_{(opt)}$	Output voltage at optimum operation
$V_{(P)GS}$	Gate-source cut-off voltage
V_R	Continuous reverse voltage; stand-off voltage
V_{RRM}	Repetitive peak reverse voltage
V_{RWM}	Crest working reverse voltage
V_{SB}	Source-substrate voltage
V_Z	Working voltage
$\frac{\Delta V}{\Delta T}$	Equivalent differential voltage change with temperature
y_{fs}	Transfer admittance (common source)
η	Efficiency
α 50%	Beamwidth between half-intensity directions
λ_{peak}	Wavelength at peak spectral response or emission
ϕ_e	Radiant output power

semiconductor index

In this alphanumeric list we present all semiconductors mentioned in this catalogue.
The second column gives the page on which abridged data can be found.
The third column is a code for the kind of product and the part of the Data Handbook System in which full information is given.

key to product code

D	Displays	SC4b	P	L.F. power transistors	SC2	T	Tuner diodes	SC1b
DT	Dual transistors	SC2	PC	Germanium point-contact diodes	SC1b	Th	Thyristors	SC1a
FET	Field-effect transistors	SC3	PDT	Photodiodes or transistors	SC4b	Tra	Transmitting transistors	SC4a
GB	Germanium gold-bonded diodes	SC1b	Ph	Photoconductive devices	SC4b	Tri	Triacs	SC1a
HF	High-frequency transistors	SC3	PhC	Photocouplers	SC4b	TS	Transient suppressor diodes	SC1a
I	Infrared devices	SC4b	R	Rectifier diodes	SC1a	Vrf	Voltage reference diodes	SC1b
LED	Light emitting diodes	SC4b	SC	Solar cells	SC4b	Vrg	Voltage regulator diodes	SC1a
LF	Low-frequency transistors	SC2	Sp	Special diodes (low leakage)	SC1b		Voltage regulator diodes	SC1b
Mm	Microminiature devices for thick and thin-film circuits	SC4c	St	Rectifier stacks	SC1a	WD	Silicon whiskerless diodes	SC1b
			Sw	Switching transistors	SC3			

type	page	product code
AA119	A10	PC
AAZ15	A10	GB
AAZ17	A10	GB
AAZ18	A10	GB
AC125	A42	LF
AC126	A42	LF
AC127	A42	LF
AC128	A42	LF
AC128/01	A42	LF
AC132	A42	LF
AC187	A42	LF
AC187/01	A42	LF
AC188	A42	LF
AC188/01	A42	LF
AF367	A50	HF
AF379	A50	HF
BA102	A11	T
BA182	A11	T
BA216	A9	WD
BA217	A9	WD
BA218	A9	WD
BA219	A9	WD
BA220	A8	WD
BA221	A8	WD
BA222	A8	WD
BA243	A11	T
BA244	A11	T
BA280	A11	T
BA314	A12	Vrg
BA314A	A12	Vrg
BA315	A12	Vrg
BA316	A8	WD
BA317	A8	WD
BA318	A8	WD
BA379	A11	T
BAS15	A9	WD
BAV10	A8	WD
BAV18	A8	WD
BAV19	A8	WD
BAV20	A8	WD
BAV21	A8	WD
BAV45	A9	Sp
BAV45A	A9	Sp
BAV70	A66	Mm
BAV99	A66	Mm
BAW21A	A8	WD
BAW21B	A8	WD
BAW56	A66	Mm
BAW62	A8	WD
BAX12	A9	WD
BAX12A	A8	WD
BAX13	A9	WD
BAX14	A9	WD
BAX14A	A8	WD
BAX15	A9	WD
BAX16	A9	WD
BAX17	A9	WD
BAX18	A9	WD
BAX18A	A8	WD
BB105A	A11	T
BB105B	A11	T
BB105G	A11	T
BB106	A11	T
BB109G	A11	T
BB110B	A11	T
BB110G	A11	T
BB117	A11	T
BB119	A11	T
BB204B	A11	T
BB204G	A11	T
BB205A	A11	T
BB205B	A11	T
BB205G	A11	T
BBY31	A66	Mm
BC107	A42	LF
BC107A	A42	LF
BC107B	A42	LF
BC108	A42	LF
BC108A	A42	LF
BC108B	A42	LF
BC108C	A42	LF
BC109	A42	LF
BC109B	A42	LF
BC109C	A42	LF
BC140	A42	LF
BC141	A42	LF
BC146	A42	LF
BC147	A42	LF
BC147A	A42	LF
BC147B	A42	LF
BC148	A42	LF
BC148A	A42	LF
BC148B	A42	LF
BC148C	A42	LF
BC149	A42	LF
BC149B	A42	LF
BC149C	A42	LF
BC157	A42	LF
BC158	A42	LF
BC158A	A42	LF
BC158B	A42	LF
BC159	A42	LF
BC159A	A42	LF
BC159B	A42	LF
BC160	A42	LF
BC161	A42	LF
BC177	A42	LF
BC178	A42	LF
BC178A	A42	LF
BC178B	A42	LF
BC179	A42	LF
BC179A	A42	LF
BC179B	A42	LF
BC200	A43	LF
BC264A	A56	FET
BC264B	A56	FET
BC264C	A56	FET
BC264D	A56	FET
BC327	A43	LF
BC328	A43	LF
BC337	A43	LF

semiconductor index

In this alphanumeric list we present all semiconductors mentioned in this catalogue.
The second column gives the page on which abridged data can be found.
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type	page	product code
BC338	A43	LF
BC368	A43	LF
BC369	A43	LF
BC546	A43	LF
BC546A	A43	LF
BC546B	A43	LF
BC547	A43	LF
BC547A	A43	LF
BC547B	A43	LF
BC547C	A43	LF
BC548	A43	LF
BC548A	A43	LF
BC548B	A43	LF
BC548C	A43	LF
BC549	A43	LF
BC549B	A43	LF
BC549C	A43	LF
BC550	A43	LF
BC550B	A43	LF
BC550C	A43	LF
BC556	A43	LF
BC556A	A43	LF
BC557	A43	LF
BC557A	A43	LF
BC557B	A43	LF
BC558	A43	LF
BC558A	A43	LF
BC558B	A43	LF
BC559	A43	LF
BC559A	A43	LF
BC559B	A43	LF
BC560	A43	LF
BC560A	A43	LF
BC560B	A43	LF
BC635	A43	LF
BC636	A44	LF
BC637	A43	LF
BC638	A44	LF
BC639	A43	LF
BC640	A44	LF
BCW29	A67	Mm
BCW30	A67	Mm
BCW31	A67	Mm
BCW32	A67	Mm
BCW33	A67	Mm
BCW69	A67	Mm
BCW70	A67	Mm
BCW71	A67	Mm
BCW72	A67	Mm
BCX17	A67	Mm
BCX18	A67	Mm
BCX19	A67	Mm
BCX20	A67	Mm
BCX51	A67	Mm
BCX52	A67	Mm
BCX53	A67	Mm
BCX54	A67	Mm
BCX55	A67	Mm
BCX56	A67	Mm
BCY30A	A44	LF
BCY31A	A44	LF
BCY32A	A44	LF
BCY33A	A44	LF
BCY34A	A44	LF
BCY56	A44	LF
BCY57	A44	LF
BCY58	A44	LF
BCY59	A44	LF
BCY70	A44	LF
BCY71	A44	LF
BCY72	A44	LF
BCY78	A44	LF
BCY79	A44	LF
BCY87	A58	DT
BCY88	A58	DT
BCY89	A58	DT
BD115	A44	P
BD131	A44	P
BD132	A44	P
BD133	A44	P
BD135	A44	P
BD136	A44	P
BD137	A44	P
BD138	A44	P
BD139	A44	P
BD140	A44	P
BD201	A44	P
BD202	A44	P
BD203	A44	P
BD204	A44	P
BD226	A44	P
BD227	A45	P
BD228	A44	P
BD229	A45	P
BD230	A44	P
BD231	A45	P
BD232	A45	P
BD233	A45	P
BD234	A45	P
BD235	A45	P
BD236	A45	P
BD237	A45	P
BD238	A45	P
BD291	A45	P
BD292	A45	P
BD293	A45	P
BD294	A45	P
BD329	A45	P
BD330	A45	P
BD331	A45	P
BD332	A45	P
BD333	A45	P
BD334	A45	P
BD335	A45	P
BD336	A45	P
BD433	A45	P
BD434	A45	P
BD435	A45	P
BD436	A45	P
BD437	A45	P
BD438	A45	P
BD645	A45	P
BD646	A45	P
BD647	A45	P
BD648	A45	P
BD649	A45	P
BD650	A45	P
BD675	A46	P
BD676	A46	P
BD677	A46	P
BD678	A46	P
BD679	A46	P
BD680	A46	P
BD681	A46	P
BD682	A46	P
BDV64	A46	P
BDV64A	A46	P
BDV64B	A46	P
BDV65	A46	P
BDV65A	A46	P
BDV65B	A46	P
BDX62	A46	P
BDX62A	A46	P
BDX62B	A46	P
BDX63	A46	P
BDX63A	A46	P
BDX63B	A46	P
BDX64	A46	P
BDX64A	A46	P
BDX64B	A46	P
BDX64C	A46	P
BDX65	A46	P
BDX65A	A46	P
BDX65B	A46	P
BDX65C	A46	P
BDX66	A46	P
BDX66A	A46	P
BDX66B	A46	P
BDX67	A46	P
BDX67A	A46	P
BDX67B	A46	P
BDX77	A46	P
BDX78	A46	P
BDX91	A47	P
BDX92	A47	P
BDX93	A47	P
BDX94	A47	P
BDX95	A47	P
BDX96	A47	P
BDY90	A47	P
BDY91	A47	P
BDY92	A47	P
BF115	A50	HF
BF180	A50	HF
BF181	A50	HF
BF182	A50	HF
BF183	A50	HF
BF184	A50	HF
BF185	A50	HF
BF194	A50	HF

key to product code

D	Displays	SC2	P	L.F. power transistors	SC2	T	Tuner diodes	SC1b
DT	Dual transistors	SC3	PC	Germanium point-contact diodes	SC1b	Th	Thyristors	SC1a
FET	Field-effect transistors	SC4a	PDT	Photodiodes or transistors	SC4b	Tra	Transmitting transistors	SC4a
GB	Germanium gold-bonded diodes	SC1b	Ph	Photoconductive devices	SC4b	Tri	Triacs	SC1a
HF	High-frequency transistors	SC3	PhC	Photocouplers	SC4b	TS	Transient suppressor diodes	SC1a
I	Infrared devices	SC4b	R	Rectifier diodes	SC1a	Vrf	Voltage reference diodes	SC1b
LED	Light emitting diodes	SC4b	SC	Solar cells	SC4b	Vrg	Voltage regulator diodes	SC1a
LF	Low-frequency transistors	SC2	Sp	Special diodes (low leakage)	SC1b		Voltage regulator diodes	SC1b
Mm	Microminiature devices for thick and thin-film circuits	SC4c	St	Rectifier stacks	SC1a	WD	Silicon whiskerless diodes	SC1b
			Sw	Switching transistors	SC3			

type	page	product code	type	page	product code	type	page	product code	type	page	product code
BF195	A50	HF	**BFQ13**	A58	FET	**BFW11**	A56	FET	**BLW84**	A63	Tra
BF196	A50	HF	**BFQ14**	A58	FET	**BFW12**	A56	FET	**BLW85**	A63	Tra
BF197	A50	HF	**BFQ15**	A58	FET	**BFW13**	A56	FET	**BLW86**	A63	Tra
BF198	A50	HF	**BFQ16**	A58	FET	**BFW16A**	A65	HF	**BLW87**	A63	Tra
BF199	A50	HF	**BFQ17**	A68	Mm	**BFW17A**	A65	HF	**BLW98**	A60	Tra
BF200	A50	HF	**BFQ18**	A68	Mm	**BFW30**	A65	HF	**BLX13**	A63	Tra
BF240	A50	HF	**BFQ19**	A68	Mm	**BFW45**	A51	HF	**BLX13C**	A63	Tra
BF241	A50	HF	**BFQ22**	A65	HF	**BFW61**	A56	FET	**BLX14**	A63	Tra
BF245A	A56	FET	**BFQ23**	A65	HF	**BFW92**	A65	HF	**BLX15**	A63	Tra
BF245B	A56	FET	**BFQ24**	A65	HF	**BFW93**	A65	HF	**BLX39**	A63	Tra
BF245C	A56	FET	**BFQ32**	A65	HF	**BFX34**	A54	Sw	**BLX65**	A62	Tra
BF246A	A56	FET	**BFQ34**	A65	HF	**BFX89**	A65	HF	**BLX66**	A62	Tra
BF246B	A56	FET	**BFQ42**	A62	Tra	**BFY50**	A51	HF	**BLX67**	A62	Tra
BF246C	A56	FET	**BFQ43**	A62	Tra	**BFY51**	A51	HF	**BLX68**	A62	Tra
BF256A	A56	FET	**BFR29**	A56	FET	**BFY52**	A51	HF	**BLX69A**	A62	Tra
BF256B	A56	FET	**BFR30**	A69	Mm	**BFY55**	A51	HF	**BLX91A**	A63	Tra
BF256C	A56	FET	**BFR31**	A69	Mm	**BFY90**	A65	HF	**BLX92A**	A63	Tra
BF324	A50	HF	**BFR49**	A65	HF	**BG1895-541**	A20	R	**BLX93A**	A63	Tra
BF327	A56	FET	**BFR53**	A68	Mm	**BG1895-641**	A20	R	**BLX94A**	A63	Tra
BF336	A50	HF	**BFR64**	A65	HF	**BGY22**	A61	Tra	**BLX95**	A63	Tra
BF337	A50	HF	**BFR65**	A65	HF	**BGY22A**	A61	Tra	**BLX96**	A60	Tra
BF338	A50	HF	**BFR84**	A56	FET	**BGY23**	A61	Tra	**BLX97**	A60	Tra
BF362	A50	HF	**BFR90**	A65	HF	**BGY23A**	A61	Tra	**BLX98**	A60	Tra
BF363	A50	HF	**BFR91**	A65	HF	**BGY32**	A61	Tra	**BLY87A**	A62	Tra
BF422	A50	HF	**BFR92**	A68	Mm	**BGY33**	A61	Tra	**BLY87C**	A62	Tra
BF423	A50	HF	**BFR93**	A68	Mm	**BGY35**	A61	Tra	**BLY88A**	A62	Tra
BF450	A50	HF	**BFR94**	A65	HF	**BGY36**	A61	Tra	**BLY88C**	A62	Tra
BF451	A50	HF	**BFR95**	A65	HF	**BGY37**	A64	HF	**BLY89A**	A62	Tra
BF457	A50	HF	**BFR96**	A65	HF	**BLW29**	A62	Tra	**BLY89C**	A62	Tra
BF458	A50	HF	**BFS17**	A68	Mm	**BLW31**	A62	Tra	**BLY90**	A60	Tra
BF459	A50	HF	**BFS18**	A68	Mm	**BLW32**	A60	Tra	**BLY91A**	A63	Tra
BF469	A50	HF	**BFS19**	A68	Mm	**BLW33**	A60	Tra	**BLY91C**	A63	Tra
BF470	A50	HF	**BFS20**	A68	Mm	**BLW34**	A60	Tra	**BLY92A**	A63	Tra
BF480	A50	HF	**BFS21**	A58	FET	**BLW60**	A62	Tra	**BLY92C**	A63	Tra
BF494	A50	HF	**BFS21A**	A58	FET	**BLW60C**	A62	Tra	**BLY93A**	A63	Tra
BF495	A50	HF	**BFS22A**	A62	Tra	**BLW64**	A60	Tra	**BLY93C**	A63	Tra
BF622	A69	Mm	**BFS23A**	A63	Tra	**BLW75**	A60	Tra	**BLY94**	A63	Tra
BF623	A69	Mm	**BFS28**	A56	FET	**BLW76**	A63	Tra	**BPW22**	A72	PDT
BF936	A50	HF	**BFT24**	A51	HF	**BLW77**	A63	Tra	**BPW34**	A72	PDT
BF939	A50	HF	**BFT25**	A68	Mm	**BLW78**	A63	Tra	**BPX25**	A72	PDT
BF967	A50	HF	**BFT44**	A51	HF	**BLW79**	A62	Tra	**BPX29**	A72	PDT
BF979	A50	HF	**BFT45**	A51	HF	**BLW80**	A62	Tra	**BPX40**	A72	PDT
BFQ10	A58	FET	**BFT92**	A68	Mm	**BLW81**	A62	Tra	**BPX41**	A72	PDT
BFQ11	A58	FET	**BFT93**	A68	Mm	**BLW82**	A62	Tra	**BPX42**	A72	PDT
BFQ12	A58	FET	**BFW10**	A56	FET	**BLW83**	A63	Tra	**BPX46A**	A75	SC

semiconductor index

In this alphanumeric list we present all semiconductors mentioned in this catalogue.
The second column gives the page on which abridged data can be found.
The third column is a code for the kind of product and the part of the Data Handbook System in which full information is given.

* = series

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BPX47A	A75	SC
BPX66P	A72	PDT
BPX70	A72	PDT
BPX71	A72	PDT
BPX72	A72	PDT
BPX94	A72	PDT
BPX95	A72	PDT
BR101	A53	Sw
BRY39	A27	Th
BRY39	A53	Sw
BRY56	A53	Sw
BSR12	A69	Mm
BSR50	A54	Sw
BSR51	A54	Sw
BSS38	A54	Sw
BSS50	A54	Sw
BSS51	A54	Sw
BSS52	A54	Sw
BSS60	A54	Sw
BSS61	A54	Sw
BSS63	A69	Mm
BSS64	A69	Mm
BSS68	A54	Sw
BSV15	A54	Sw
BSV16	A54	Sw
BSV17	A54	Sw
BSV52	A69	Mm
BSV64	A54	Sw
BSV78	A57	FET
BSV79	A57	FET
BSV80	A57	FET
BSV81	A57	FET
BSW41A	A54	Sw
BSW66	A54	Sw
BSW67	A54	Sw
BSW68	A54	Sw
BSX19	A54	Sw
BSX20	A54	Sw
BSX21	A54	Sw
BSX45	A54	Sw
BSX46	A54	Sw
BSX47	A54	Sw
BSX59	A54	Sw
BSX60	A54	Sw
BSX61	A54	Sw
BT137*	A28	Tri
BT138*	A28	Tri
BT139*	A28	Tri
BT151	A25	Th
BTW23*	A26	Th
BTW24*	A26	Th
BTW30*	A27	Th
BTW31*	A27	Th
BTW33*	A27	Th
BTW34*	A29	Tri
BTW38*	A25	Th
BTW40*	A26	Th
BTW41*	A29	Tri
BTW42*	A25	Th
BTW43*	A29	Tri
BTW45*	A25	Th
BTW47*	A25	Th
BTW92*	A26	Th
BTX18*	A25	Th
BTX94*	A29	Tri
BTY79*	A25	Th
BTY87*	A25	Th
BTY91*	A25	Th
BU126	A47	P
BU133	A47	P
BU204	A47	P
BU205	A47	P
BU206	A47	P
BU207A	A47	P
BU208A	A47	P
BU209A	A47	P
BU326A	A47	P
BU426	A47	P
BUX80	A47	P
BUX81	A47	P
BUX82	A47	P
BUX83	A47	P
BUX84	A47	P
BUX85	A47	P
BUX86	A47	P
BUX87	A47	P
BUY86	A54	Sw
BUY87	A54	Sw
BUY88	A54	Sw
BY164	A19	R
BY179	A19	R
BY184	A20	R
BY188A	A19	R
BY188B	A19	R
BY206	A21	R
BY207	A21	R
BY208*	A21	R
BY209	A20	R
BY223	A19	R
BY224*	A19	R
BY225*	A19	R
BY226	A18	R
BY227*	A19	R
BY406	A21	R
BY407	A21	R
BY409	A20	R
BY476	A20	R
BY477	A20	R
BY478	A20	R
BYW19*	A21	R
BYW29*	A21	R
BYW30*	A21	R
BYW31*	A21	R
BYW54	A20	R
BYW55	A20	R
BYW56	A20	R
BYW92*	A21	R
BYX10	A18	R
BYX22*	A18	R
BYX25*	A20	R
BYX30*	A21	R
BYX32*	A19	R
BYX35	A20	R
BYX36*	A18	R
BYX38*	A18	R
BYX39*	A20	R
BYX42*	A18	R
BYX45*	A20	R
BYX46*	A21	R
BYX49*	A18	R
BYX50*	A21	R
BYX52*	A19	R
BYX55*	A21	R
BYX56*	A20	R
BYX71*	A21	R
BYX72*	A18	R
BYX90	A20	R
BYX91*	A20	R
BYX96*	A18	R
BYX97*	A19	R
BYX98*	A18	R
BYX99*	A18	R
BZV10	A12	Vrf
BZV11	A12	Vrf
BZV12	A12	Vrf
BZV13	A12	Vrf
BZV14	A12	Vrf
BZV15*	A13	Vrg
BZV38	A12	Vrf
BZV46*	A12	Vrg
BZW10	A23	TS
BZW70*	A23	TS
BZW86*	A23	TS
BZW91*	A23	TS
BZW93*	A23	TS
BZX55*	A14	Vrg
BZX61*	A15	Vrg
BZX70*	A13	Vrg
BZX75*	A12	Vrg
BZX79*	A14	Vrg
BZX84*	A66	Mm
BZX85*	A15	Vrg
BZX87*	A15	Vrg
BZX90	A12	Vrf
BZX91	A12	Vrf
BZX92	A12	Vrf
BZX93	A12	Vrf
BZY78	A12	Vrf
BZY88*	A15	Vrg
BZY91*	A13	Vrg
BZY93*	A13	Vrg
BZY95*	A13	Vrg
BZY96*	A13	Vrg
BZZ14 to 29	A13	Vrg
CNY22	A80	PhC
CNY23	A80	PhC
CNY42	A80	PhC
CNY43	A80	PhC
CNY44	A80	PhC
CNY46	A80	PhC
CNY47	A80	PhC
CNY47A	A80	PhC
CNY48	A80	PhC

key to product code

D	Displays	SC4b	P	L.F. power transistors	SC2	T	Tuner diodes	SC1b
DT	Dual transistors	SC2	PC	Germanium point-contact diodes	SC1b	Th	Thyristors	SC1a
FET	Field-effect transistors	SC3	PDT	Photodiodes or transistors	SC4b	Tra	Transmitting transistors	SC4a
GB	Germanium gold-bonded diodes	SC1b	Ph	Photoconductive devices	SC4b	Tri	Triacs	SC1a
HF	High-frequency transistors	SC3	PhC	Photocouplers	SC4b	TS	Transient suppressor diodes	SC1a
I	Infrared devices	SC4b	R	Rectifier diodes	SC1a	Vrf	Voltage reference diodes	SC1b
LED	Light emitting diodes	SC4b	SC	Solar cells	SC4b	Vrg	Voltage regulator diodes	SC1a
LF	Low-frequency transistors	SC2	Sp	Special diodes (low leakage)	SC1b		Voltage regulator diodes	SC1b
Mm	Microminiature devices for thick and thin-film circuits	SC4c	St	Rectifier stacks	SC1a	WD	Silicon whiskerless diodes	SC1b
			Sw	Switching transistors	SC3			

type	page	product code
CQX85	A78	D
CQX85A	A78	D
CQY11B	A76	LED
CQY11C	A76	LED
CQY24A	A76	LED
CQY46	A76	LED
CQY47	A76	LED
CQY49B	A76	LED
CQY49C	A76	LED
CQY50	A76	LED
CQY52	A76	LED
CQY54	A76	LED
CQY58	A76	LED
CQY61B	A76	LED
CQY81	A78	D
CQY81A	A78	D
CQY81B	A78	D
CQY82	A78	D
CQY82A	A78	D
CQY82B	A78	D
CQY84	A78	D
CQY88	A76	LED
CQY89	A76	LED
CQY94	A76	LED
CQY95	A76	LED
CQY96	A76	LED
CQY97	A76	LED
OA47	A10	GB
OA90	A10	PC
OA91	A10	PC
OA95	A10	PC
ORP10	A74	I
ORP13	A74	I
ORP60	A70	Ph
ORP61	A70	Ph
ORP62	A70	Ph
ORP66	A70	Ph
ORP68	A70	Ph
ORP69	A70	Ph
OSB9110*	A22	St
OSB9210*	A22	St
OSB9310*	A22	St
OSB9410*	A22	St
OSM9110*	A22	St
OSM9210*	A22	St
OSM9310*	A22	St
OSM9410*	A22	St
OSS9110*	A22	St
OSS9210*	A22	St
OSS9310*	A22	St
OSS9410*	A22	St
RPY58A	A70	Ph
RPY71	A70	Ph
RPY76A	A74	I
RPY82	A70	Ph
RPY84	A70	Ph
RPY85	A70	Ph
1N750A to 1N759A	A14	Vrg
1N821	A12	Vrf
1N823	A12	Vrf
1N825	A12	Vrf
1N827	A12	Vrf
1N829	A12	Vrf
1N914	A8	WD
1N914A	A8	WD
1N916	A8	WD
1N916A	A8	WD
1N916B	A8	WD
1N957B to 1N982B	A14	Vrg
1N3880	A21	R
1N3881	A21	R
1N3882	A21	R
1N3890	A21	R
1N3891	A21	R
1N3892	A21	R
1N4009	A8	WD
1N4148	A8	WD
1N4150	A8	WD
1N4151	A8	WD
1N4154	A8	WD
1N4446	A8	WD
1N4448	A8	WD
1N5729B to 1N5757B	A14	Vrg
2N918	A51	HF
2N929	A47	LF
2N930	A47	LF
2N1613	A51	HF
2N1711	A51	HF
2N1893	A51	HF
2N2218	A55	Sw
2N2218A	A55	Sw
2N2219	A55	Sw
2N2219A	A55	Sw
2N2221	A55	Sw
2N2221A	A55	Sw
2N2222	A55	Sw
2N2222A	A55	Sw
2N2297	A51	HF
2N2368	A55	Sw
2N2369	A55	Sw
2N2369A	A55	Sw
2N2483	A47	LF
2N2484	A47	LF
2N2894	A55	Sw
2N2894A	A55	Sw
2N2904	A55	Sw
2N2904A	A55	Sw
2N2905	A55	Sw
2N2905A	A55	Sw
2N2906	A55	Sw
2N2906A	A55	Sw
2N2907	A55	Sw
2N2907A	A55	Sw
2N3019	A55	Sw
2N3020	A55	Sw
2N3375	A63	Tra
2N3553	A63	Tra
2N3632	A63	Tra
2N3823	A56	FET
2N3866	A63	Tra
2N3924	A62	Tra
2N3926	A62	Tra
2N3927	A62	Tra
2N3966	A57	FET
2N4030	A51	HF
2N4031	A51	HF
2N4032	A51	HF
2N4033	A51	HF
2N4036	A55	Sw
2N4091	A57	FET
2N4092	A57	FET
2N4093	A57	FET
2N4391	A57	FET
2N4392	A57	FET
2N4393	A57	FET
2N4427	A62	Tra
2N4856	A57	FET
2N4857	A57	FET
2N4858	A57	FET
2N4859	A57	FET
2N4860	A57	FET
2N4861	A57	FET
2N5415	A55	Sw
2N5416	A55	Sw
61SV	A74	I
RTC2001	A60	–
RTC2005	A60	–
RTC2010	A60	–

small-signal diodes

silicon

Whiskerless
- high surge immunity
- high resistance to shock
- two-way heat transfer
- low leakage
- simple, sturdy construction
- hermetic capsule
- as good as, or better than MIL-S-19500

We supply
- to any world standardized JEDEC or PRO ELECTRON specification
- to any customer specification

Whiskerless in DO-35

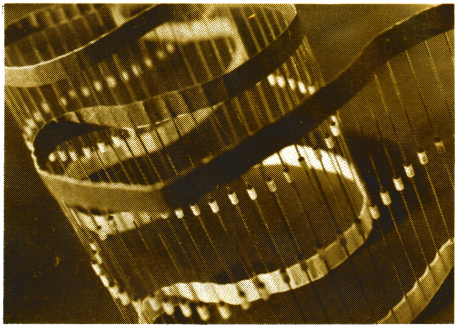
max values

	type	status	V_R	I_F	I_{FRM}	t_{rr} *	C_d	V_F at I_F = mA					
								10	20	30	50	100	200
			V	mA	mA	ns	pF	V	V	V	V	V	V
general purpose	**BA220**	D	–	200	400	4	2,5	0,75	0,8	0,84	0,88	0,95	1,05
	BA221	C	30	200	400	4	2,5	0,75	0,8	0,85	0,9	0,95	1,05
	BA222	C	50	75	150	4	2	0,9	0,98	1,05	1,1	1,4	–
	BA316	D	10	100	225	4	3	0,85	0,92	0,97	1,02	1,1	–
	BA317	D	30	100	225	4	3	0,85	0,92	0,97	1,02	1,1	–
	BA318	D	50	100	225	4	3	0,85	0,92	0,97	1,02	1,1	–
	BAX14A	D	20	500	2000	300▲	35	–	–	–	–	0,85	0,92
see stabistors	**BA314**	D	–	100	250	–	140	0,83	0,87	0,89	0,92	0,96	–
	BA314A	D	–	100	250	–	110	0,81	0,85	0,88	0,93	1	–
	BA315	D	–	100	225	–	3	0,79	0,85	0,89	0,95	1,05	–
high-speed switching	**BAW62**	D	75	100	225	4**	2	0,78	0,8	0,82	0,88	1	1,28
	1N914	C	75	75	225	4	4	1	–	–	–	–	–
	1N914A	C					4	–	1	–	–	–	–
	1N916	C					2	1	–	–	–	–	–
	1N916A	C					2	–	1	–	–	–	–
	1N916B	C					2	–	–	–	1,1	–	–
	1N4009	D	25	–	–	2	4	–	–	1	–	–	–
	1N4148	D	75	75	225	4	4	1	–	–	–	–	–
	1N4151	D	50	200	450	2	2	–	–	–	1	–	–
	1N4154	D	25	200	450	2	4	–	–	1	–	–	–
	1N4446	D	75	200	450	4	4	–	1	–	–	–	–
	1N4448	D	75	200	450	4	4	–	–	–	–	1	–
high-speed core gating	**BAV10**	D	60	300	600	6▲▲	2,5	0,75	0,78	0,8	0,85	0,92	1
	1N4150	D	50	300	600	6▲▲	2,5	0,74	–	–	0,86	0,92	1
high-speed, high voltage	**BAV18**	D	50	250	625	50▲	5	0,8	–	–	–	1	1,25
	BAV19	D	100	250	625	50▲	5	0,8	–	–	–	1	1,25
	BAV20	D	150	250	625	50▲	5	0,8	–	–	–	1	1,25
	BAV21	D	200	250	625	50▲	5	0,8	–	–	–	1	1,25
avalanche for telephony	**BAW21A**	D	70	400	800	300▲	35	–	–	–	–	–	1
	BAW21B	D	90	400	800	300▲	35	–	–	–	–	–	1
	BAX12A	D	90	400	800	50▲	35	0,75	–	–	0,84	0,90	1
											at 400 mA:		1,25
rectifier applications	**BAX18A**	D	75	500	2000	–	–	–	–	–	0,80	0,86	0,91
											at 400 mA:		1

* I_F = 10 mA to I_R = 60 mA, R_L = 100 Ω. Measured at I_R = 1 mA.
** I_F = 10 mA to I_R = 10 mA, R_L = 100 Ω. Measured at I_R = 1 mA.
▲ I_F = 30 mA to I_R = 30 mA, R_L = 100 Ω. Measured at I_R = 3 mA.
▲▲ I_F = 400 mA to I_R = 400 mA, R_L = 100 Ω. Measured at I_R = 40 mA.

Whiskerless in hard glass envelopes for demanding service in industry and telephony.

Low leakage (picoampere) diodes for clamping, holding, peak followers, delay, log amps, IGFETS.



Bandolier packed (9000 diodes per reel) for simple mechanical or manual handling.

Whiskerless in SOD-17

max values

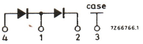
	type	status	V_R	I_F	I_{FRM}	t_{rr} *	C_d	V_F at I_F = mA					
								1	10	20	50	100	400
			V	mA	mA	ns	pF	V	V	V	V	V	V
general purpose	**BA216**	C	–	75	150	4	3	0,71	0,92	1,1	1,45	–	–
	BA217	C	30	75	150	4	3	0,7	1	1,2	1,5	–	–
	BA218	C	50	75	150	4	3	0,7	1	1,2	1,5	–	–
	BA219	C	100	100	300	120**	5	0,65	0,85	1	1,2	1,4	–
general industrial	**BAX13**	C	50	75	150	4	3	–	0,9	1	1,3	1,75	–
	BAX14	C	20	500	2000	50**	35	0,6	0,7	0,74	0,82	0,9	–
	BAX15	C	150	250	500	300**	20	–	0,65	0,74	0,85	1	1,7
	BAX16	C	150	200	300	120**	10	0,65	0,85	0,93	1,1	1,3	–
	BAX17	C	200	200	300	120**	10	0,65	0,75	0,83	0,98	1,1	–
	BAX18	C	75	500	2000	–	–	–	–	0,75	0,85	0,9	1,1
avalanche for telephony	**BAX12**	C	90	400	800▲	50**	35	–	0,75	0,78	0,84	0,90	1,25

Whiskerless in DO-34

	type	status	V_R	I_F	I_{FRM}	t_{rr} *	C_d	V_F at I_F = mA					
								1	10	20	50	100	400
			V	mA	mA	ns	pF	V	V	V	V	V	V
general purpose	**BAS15**	N	50	75	150	4	3	0,7	1	–	1,5	–	–

Low leakage

type	status	case	V_R V	I_F mA	I_R at pA	V_R and V	T_j °C	C_d	V_F at I_F = 10 mA
BAV45	D	TO-18(3)	20	50	5	5	25	1,3	1
					10	20	25		
					250	5	80		
BAV45A	N	TO-72(7)	BAV45A = two diodes BAV45 in one envelope						



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* I_F = 10 mA to I_R = 60 mA, R_L = 100 Ω. Measured at I_R = 1 mA.

** I_F = 30 mA to I_R = 30 mA, R_L = 100 Ω. Measured at I_R = 3 mA.

▲ I_{FSM} = 30 A for t = 10 µs.

small-signal diodes

germanium

for detection, switching and general purposes

Point contact

max values

	type	status	case	V_R	I_F	I_{FRM}	t_{rr}	C_d	V_F at I_F = mA		
									0,1	10	30
				V	mA	mA	ns	pF	V	V	V
general purpose	**OA90**	D	DO-7	20	8	45	–	–	0,25	1,5	3,2
	OA91			90	50	150				1,9	3,3
	OA95			90	50	150				1,5	2,6
a.m. and f.m. detection	**AA119**	D	DO-7	30	35	100	–	–	0,3	2,2	4
	2-AA119										

Gold bonded

	type	status	case	V_R	I_F	I_{FRM}	t_{rr} *	C_d	V_F at I_F = mA		
									30	150	250
				V	mA	mA	ns	pF	V	V	V
general purpose	**AAZ15**	D	DO-7	75	140	250	–	2	0,57	0,9	1,1
	AAZ17			50							
general purpose and switching	**AAZ18**	D	DO-7	20	130	300	70	2,5	0,5	0,75	–
	OA47			25	110	150		3,5	0,65	1,1	

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* I_F = 10 mA to I_R = 10 mA, R_L = 100 Ω. Measured at I_R = 1 mA.

tuner diodes

Testing of low-power diodes.

Variable capacitance

	type	status	case	V_R V	C_d pF	at V_R V	C_d ratio	at .V/..V	r_D Ω	at C_d pF
a.f.c. in radio and television	**BA102**	C	DO-7	20	20-45	4	> 1,4	4/10	3	20-45
	BB117	C	SOD-23	20	2,2-4,0	15	> 2	4/15	1,2	9
	BB119	D	DO-35	15	20-25	4	> 1,3	4/10	1,5	–
radio f.m.	**BB110B**	C	SOD-23	30	29-33	3	2,65	3/30	0,4	30
	BB110G	C	SOD-23	30	27-31	3	2,65	3/30	0,4	30
	BB204B	D	TO-92(6)	30	37-42	3	2,65	3/30	0,4	38
	BB204G	D		30	34-39	3	2,65	3/30	0,4	38
television v.h.f. band I to 88 MHz and	**BB106**	C	SOD-23	28	4-5,6	25	> 4,5	3/25	0,6	25
band III to 230 MHz	**BB109G**	D	SOD-23	28	4,3-6	25	> 5	3/25	0,6	25
band I to 88 MHz and	**BB105G**	D	SOD-23	28	1,8-2,8	25	> 4	3/25	1,2	9
band III to 230 MHz	**BB205G**	D	SOD-23	28	1,8-2,8	25	> 4,3	3/25	1,2	9
television u.h.f.	**BB105A**	D	SOD-23	28	2,3-2,8	25	> 4	3/25	0,8	9
bands IV & V to 790 MHz	**BB205A**	D	SOD-23	28	2,0-2,5	25	> 4,3	3/25	0,8	9
bands IV & V to 860 MHz	**BB105B**	D	SOD-23	28	2,0-2,3	25	> 4,5	3/25	0,8	9
	BB205B	D	SOD-23	28	1,9-2,2	25	> 5	3/25	0,8	9

Band switching

	type	status	case	V_R V	C_d pF	at V_R V	I_F mA	F dB	r_D Ω	at I_F mA
switching	**BA182**	D	SOD-23	35	1	20	100	–	0,7	5
	BA243	D	DO-35	20	2	15	100	–	1	10
	BA244	D	DO-35	20	2	15	100	–	0,5	10

Various

	type	status	case	V_R V	C_d pF	at V_R V	I_F mA	F dB	r_D Ω	at I_F mA
u.h.f. mixer diode (Schottky barrier)	**BA280**	D	SOD-23	4	1	0	30	typ 6,5	–	–
attenuator diode (p-i-n)	**BA379**	D	SOD-52	30	typ 0,3 (900 MHz)	0	20	–	6,5 (35 MHz)	10

Note
All BB105, BB106 and BB205 types will be supplied in matched sets.
Over the voltage range 0,5 V to 28 V the diodes in a set are capacitance matched to within 3%, for all mentioned types except **6%, for BB105G.**

voltage reference diodes

With very low temperature coefficient;
ideal for top-class voltage reference sources.

type	status	case	reference voltage at I_Z V (nom)	mA	voltage tolerance (±)%	I_{ZM} (I_{ZRM}) mA	S_Z %/°C	at I_Z mA	r_{diff} max Ω	at I_Z mA
BZX90	D	DO-35	6,5	7,5	5	50	< 0,01	7,5	15	7,5
BZX91							< 0,005			
BZX92							< 0,002			
BZX93							< 0,001			
1N821	D	DO-35	6,2	7,5	5	50	± 0,01	7,5	15	7,5
1N823	D						± 0,005			
1N825	D						± 0,002			
1N827	D						± 0,001			
1N829	N						± 0,0005			
BZY78	C	DO-7	5,3	11,5	+ 0,3 V − 0,2 V	(25)	+ 0,006 − 0,004	11,5	20	11,5
BZV10	D	DO-35	6,5	2	5	50	± 0,01	2	50	2
BZV11							± 0,005			
BZV12							± 0,002			
BZV13							± 0,001			
BZV14							± 0,0005			
BZV38	D	DO-35	6,4	7,5	5	50	< 20 mV	7,5	20	7,5

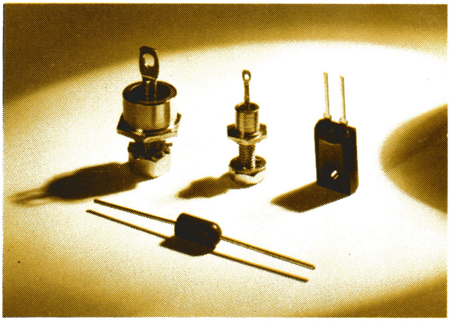
stabistors

Low-voltage regulator diodes — used in forward direction
for all shifting, coupling, clamping, protecting, bias regulating.

type	status	case	V_F at I_F = 1 mA min V	max V	V_F at I_F = 10 mA min V	max V	I_{FRM} mA	V_R = V_{RRM} V	S_F typ at I_F = 1 mA mV/°C	and r_{diff} Ω
BA314	D	DO-35	0,68	0,76	0,75	0,83	250	—	− 1,8	30
BA314A			0,65	0,73	0,73	0,81	250	—	− 1,8	30
BA315			0,59	0,66	0,71	0,79	225	—	− 2,1	50
BZV46-C1V5	N	DO-35	1,35	1,55	—	—	120	4	− 3,7	20
BZV46-C2V0			2,0	2,3			80		− 5,6	30
BZX75-C1V4	D	DO-7	1,16	1,34	1,33	1,47	250	10	− 4	60
BZX75-C2V1			1,75	2,05	1,99	2,21			− 6	90
BZX75-C2V8			2,33	2,70	2,66	2,94			− 8	120
BZX75-C3V6			3,02	3,45	3,42	3,78			−10	150

1. For BZY78 S_Z values: +0,006 at T_j = −40 to +25 °C.
   −0,004 at T_j = 25 to 100 °C.
2. For BZV38 $\Delta V_{ref} < 20$ mV at T_j = 10 to 60 °C.
3. For BA314 to 315 see also small-signal diodes (whiskerless).
4. For BZV46 V_F, S_F and r_{diff} are measured at I_F = 5 mA.

voltage regulator diodes



Medium to high power (Handbook SC1a)

- smoothing
- limiting
- suppressing line transients
- regulating
- protecting

Normal polarity (cathode to stud)	**no end-letter**
Reverse polarity (anode to stud)	**R**
Both polarities available	**(R)**

Series number	**BZY96–...**	**BZY95–...**	**BZX70–...**	**BZZ..**	**BZV15–...(R)**	**BZY93–...(R)**	**BZY91–...(R)**
P_{tot}(W)	**1,5**	**1,5**	**2,5**	**10**	**15**	**20**	**75**
up to T_{amb} (°C)	25	25	25	–	–	–	–
up to T_{mb} (°C)	–	–	–	50	82	75	65
Voltage tolerance (%)	5	5	5	5	5	5	5
I_{ZRM} (A)	3,5	5	5	7	–	20	100
P_{ZSM} (W)	20	100	100	45	400	500	4400
$T_{j\,max}$ (°C)	175	175	150	150	150	175	175
Case	DO-1	DO-1	SOD-18	DO-4(1)	SOD-38	DO-4(1)	DO-5(1)
Status	D	C	D	14 to 19 : D 20 to 29 : C	D	D	D

Nominal voltage	BZY96–...	BZY95–...	BZX70–...	BZZ..	BZV15–...(R)	BZY93–...(R)	BZY91–...(R)
3,9							
4,3							
4,7	C4V7						
5,1	C5V1						
5,6	100 C5V6			14			
6,2	C6V2			15			
6,8	C6V8			16			
7,5	C7V5			17		2A C7V5	
8,2	50 C8V2			18		C8V2	
9,1	C9V1			19		C9V1	
10		C10	C10	20	C10	C10	C10
11		C11	C11	21	C11	C11	C11
12		50 C12	50 C12	20 22	1A C12	1A C12	2A C12
13		C13	C13	23	C13	C13	C13
15		C15	C15	24	C15	C15	C15
16		C16	C16	25	C16	C16	C16
18		C18	C18	26	C18	C18	C18
20		C20	C20	27	C20	C20	C20
22		20 C22	C22	28	500 C22	500 C22	C22
24		C24	20 C24	29	C24	C24	C24
27		C27	C27		C27	C27	1A C27
30		C30	C30		C30	C30	C30
33		C33	C33		C33	C33	C33
36		C36	C36		C36	C36	C36
39		C39	C39		C39	C39	C39
43		C43	C43		C43	C43	C43
47		C47	C47		200 C47	200 C47	C47
51		10 C51	10 C51		C51	C51	500 C51
56		C56	C56		C56	C56	C56
62		C62	C62		C62	C62	C62
68		C68	C68		C68	C68	C68
75		C75	C75		C75	C75	C75
82							
91							
100							

current in mA (< 1 A) or A (≥ 1 A) at which nominal voltage is specified

voltage regulator diodes

Low power (Handbook SC1b)

- low leakage current
- low differential resistance
- low capacitance
- sharp knee
- high surge immunity
- standard or custom specifications
- standardized envelopes
- types in DO-7 and DO-35 envelopes bandolier packed

Series number	**1N75 . A**		**1N9 . . B**		**1N57 . . .**		**BZX55– . . .**		**BZX79– . . .**	
P_{tot} (mW)	**20**		**400**		**400**		**400**		**400**	
up to T_{amb} (°C)	50		50		50		50		50	
Voltage tolerance (%)	5		5		5		5		2 or 5 *	
I_{FRM} (mA)	–		–		250		250		250	
I_{ZRM} (mA)	–		–		–		–		–	
P_{ZSM} (W)	–		–		30		30		30	
$T_{j\,max}$ (°C)	–		–		200		200		200	
Case	DO-35		DO-35		DO-35		DO-35		DO-35	
Status	C		C		D		D N for 2,4 to 4,3 V		D N for 2,4 to 4,3	
Nominal voltage										
2,4							C2V4		C2V4	
2,7							C2V7		C2V7	
3,0							C3V0		C3V0	
3,3							C3V3		C3V3	
3,6							C3V6		C3V6	
3,9							C3V9		C3V9	
4,3							C4V3		C4V3	
4,7							C4V7		C4V7	
5,1	751A				5729B		C5V1		C5V1	
5,6	752A				30B		C5V6		C5V6	
6,2	753A				31B		C6V2		C6V2	
6,8	754A		957B	18,5	32B		C6V8		C6V8	5
7,5	755A	20	958B		33B	10	C7V5		C7V5	
8,2	756A		959B		34B		C8V2		C8V2	
9,1	757A		960B		35B		C9V1	5	C9V1	
10	758A		961B		36B		C10		C10	
11			962B	11,5	37B		C11		C11	
12	759A		963B	10,5	38B		C12		C12	
13			964B		39B		C13		C13	
15			965B		40B	5	C15		C15	
16			966B		41B		C16		C16	
18			967B		42B		C18		C18	
20			968B	6,2	43B		C20		C20	
22			969B	5,6	44B		C22		C22	
24			970B		45B		C24		C24	
27			971B		46B		C27		C27	
30			972B		47B		C30		C30	
33			973B		48B		C33		C33	
36			974B	3,4	49B		C36		C36	
39			975B	3,2	50B		C39		C39	
43			976B		51B		C43		C43	2
47			977B		52B	2	C47		C47	
51			978B		53B		C51	2,5	C51	
56			979B		54B		C56		C56	
62			980B	2,0	55B		C62		C62	
68			981B	1,8	56B		C68		C68	
75			982B	1,7	5757B		C75		C75	
82										
91										
100										
110										
120										
130										

current in mA at which nominal voltage is specified

* 4,7 to 75 V (suffixes B4V7 to B75) available with 2% tolerance.

Series number	**BZY88– . . .**	**BZX85– . . .**	**BZX61– . . .**	**BZX87– . . .**
P_{tot} (mW)	**400**	**1000**	**1300**	**1500**
up to T_{amb} (°C)	50	25	25	25
Voltage tolerance (%)	5	5	5	5
I_{FRM} (mA)	250	—	1000	400
I_{ZRM} (mA)	250	—	—	—
P_{ZSM} (W)	15	—	300	100
$T_{j\,max}$ (°C)	200	—	175	200
Case	DO-7	DO-41	SOD-22	SOD-51
Status	D	N	D	D

Nominal voltage		BZY88		BZX85		BZX61		BZX87
2,4								
2,7								
3,0								
3,3		C3V3						
3,6		C3V6						
3,9		C3V9						
4,3		C4V3						
4,7		C4V7						
5,1		C5V1	**45**	C5V1				C5V1
5,6		C5V6		C5V6			**50**	C5V6
6,2		C6V2		C6V2				C6V2
6,8		C6V8	**35**	C6V8				C6V8
7,5		C7V5		C7V5		C7V5		C7V5
8,2		C8V2		C8V2		C8V2		C8V2
9,1	**5**	C9V1	**25**	C9V1		C9V1		C9V1
10		C10		C10	**20**	C10	**20**	C10
11		C11		C11		C11		C11
12		C12	**20**	C12		C12		C12
13		C13		C13		C13		C13
15		C15		C15		C15		C15
16		C16	**15**	C16		C16		C16
18		C18		C18		C18		C18
20		C20		C20		C20		C20
22		C22	**10**	C22		C22		C22
24		C24		C24	**10**	C24	**10**	C24
27		C27		C27		C27		C27
30		C30	**8**	C30		C30		C30
33				C33		C33		C33
36				C36		C36		C36
39			**6**	C39		C39		C39
43				C43		C43		C43
47				C47		C47		C47
51				C51		C51	**5**	C51
56				C56		C56		C56
62			**4**	C62		C62		C62
68				C68	**5**	C68		C68
75				C75		C75		C75
82						C82		
91						C91		
100						C100		
110						C110		
120						C120		
130						C130		

current in mA at which nominal voltage is specified

rectifier diodes

selection guide

General purpose (pages A18/A19)

$I_{F(AV)max}$ A		V_{RRMmax} (V) 150	300	500	600	650	800	1000	1200	1250	1600
0,36	BYX10										●
0,8	BYX36	●	●		●						
1,33	BY226					●					
1,33	BY227									●	
1,4	BYX22				●				●		
6	BYX49		●		●				●		
6	BYX38		●		●				●		
10	BYX98		●		●				●		
10	BYX72	●	●	●							
12	BYX42		●		●				●		
15	BYX99		●		●				●		
30	BYX96		●		●				●		●
47	BYX52		●		●				●		
47	BYX97		●		●				●		●
150	BYX32				●		●	●	●		●

Avalanche (page A20)

$I_{F(AV)max}$ A		V_{RWMmax} (V) 600	800	1000
1,5	BYX45	●	●	●
2	BYW54	●		
2	BYW55		●	
2	BYW56			●
9,5	BYX39	●	●	●
20	BYX25	●	●	●
47	BYX56	●	●	●

Bridges (page A19)

$I_{O(AV)max}$ A		$V_{I(RMS)max}$ (V) 50	60	80	280
1	BY179				●
1,4	BY164		●		
3,6	BY224				●
4,8	BY225	●		●	

Efficiency diodes (page A19)

$I_{F(AV)max}$ A	I_{FWMmax} A		V_{RRMmax} (V) 50	600	750	1500
1,2		BY188	●			
	5	BY223				●
	10	BY277		●	●	

Fast soft-recovery (page A21)

$I_{F(AV)max}$		V_{RRMmax} (V)										
A		50	100	150	200	300	350	400	500	600	800	1000
0,4	BY206						●					
0,4	BY207									●		
0,75	BY208									●	●	●
0,8	BY406						●					
0,8	BY407									●		
1,2	BYX55						●			●		
6	1N3880		●									
6	1N3881				●							
6	1N3882					●						
7	BYW19										●	●
7	BYX50				●	●						
7	BYX71						●			●		
12	1N3890		●									
12	1N3891				●							
12	1N3892					●						
14	BYX30				●	●		●	●	●		
22	BYX46				●	●		●	●	●		
Very fast recovery (page A21)												
7	BYW29	●	●	●								
12	BYW30	●	●	●								
25	BYW31	●	●	●								
35	BYW92	●	●	●								

E.H.T. rectifiers (page A20)

$I_{F(AV)max}$		V_{RRMmax} (kV)							
mA		1,8	7,5	12,5	18	23	27,5	37,5	115 to 225
2	BY477					●			
2	BY478						●		
2,5	BY209			●					
2,5	BY409			●					
2,5	BY476				●				
5	BY184	●							
50	BYX35							●	
200	BYX90		●						
200	BYX91								●

Voltage tripler units (page A20) E.H.T. output: 1,7 mA; 27,5 kV BG1895–541
BG1895–641

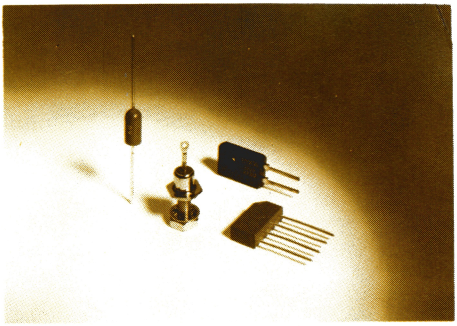
rectifier diodes

abridged data

Normal polarity (cathode to stud)	**no end-letter**
Reverse polarity (anode to stud)	**R**
Both polarities available	**(R)**

General purpose

type		status	case	RATINGS $I_{F(AV)}$ A	V_{RRM} V	V_{RWM} V	I_{FRM} A	I_{FSM} and T_{jmax}; t = 10 ms A	I^2t A^2s	CHARACTERISTICS I_{Rmax} $T_j \geqslant 125$ °C mA
BYX10		D	DO-14	**0,36**	1600	800	3	15	–	0,05
BYX36	– 150	C	DO-15	**0,8**	150	100	5	30	–	0,12
	– 300				300	200				
	– 600				600	400				
BY226		D	SOD-18	**1,33**	650	450	10	50	–	0,2
BY227					1250	800				
BYX22	– 600	C	DO-1	**1,4**	600	400	15	40	–	0,12
	–1200				1200	800				
BYX49	– 300(R)	D	SOD-38	**6**	300	200	20	40	8	0,2
	– 600(R)				600	400				
	–1200(R)				1200	800				
BYX38	– 300(R)	D	DO-4(1)	**6**	300	200	50	50	13	0,2
	– 600(R)				600	400				
	–1200(R)				1200	800				
BYX98	– 300(R)	D	DO-4(1)	**10**	300	200	75	75	28	0,2
	– 600(R)				600	400				
	–1200(R)				1200	800				
BYX72	– 150(R)	N	SOD-38	**10**	150	100	50	100	50	0,5
	– 300(R)				300	200				
	– 500(R)				500	400				
BYX42	– 300(R)	D	DO-4(1)	**12**	300	200	60	125	75	0,2
	– 600(R)				600	400				
	–1200(R)				1200	800				
BYX99	– 300(R)	D	DO-4(1)	**15**	300	200	180	180	162	0,2
	– 600(R)				600	400				
	–1200(R)				1200	800				
BYX96	– 300(R)	D	DO-4(3)	**30**	300	200	400	400	800	1
	– 600(R)				600	400				
	–1200(R)				1200	800				
	–1600(R)				1600	800				



General purpose

type		status	case	RATINGS **$I_{F(AV)}$**	V_{RRM}	V_{RWM}	I_{FRM}	I_{FSM} and T_{jmax}; t = 10 ms	I^2t	CHARACTERISTICS I_{Rmax} $T_j \geqslant 125\,°C$
				A	V	V	A	A	A^2s	mA
BYX97	– 300(R)	D	DO-5(2)	**47**	300	200	550	800	3200	4
	– 600(R)				600	400				
	–1200(R)				1200	800				
	–1600(R)				1600	800				
BYX52	– 300(R)	C	DO-5(1)	**47**	300	200	450	800	3200	1,6
	– 600(R)				600	400				
	–1200(R)				1200	800				
BYX32	– 600(R)	D	SOD-8	**150**	600	600	750	1600	12800	24
	– 800(R)				800	800				18
	–1000(R)				1000	1000				15
	–1200(R)				1200	1200				12
	–1600(R)				1600	1200				12

Bridges

values quoted are max

type		status	case	INPUT $V_{I(RMS)}$	V_{IRM}	V_{IWM}	I_{ISM}	OUTPUT **$I_{O(AV)}$ R loaded**	I_{ORM}
				V	V	V	A	**A**	A
BY179		D	SOD-28	280	800	400	25	**1**	5
BY164		D	SOD-28	60	120	85	25	**1,4**	5
BY224	– 600	D	SOT-112	280	600	400	60	**3,6**	50
	– 850				850				
BY225	– 100	D	SOT-112	50	100	70	100	**4,8**	50
	– 200			80	200	112			

Efficiency diodes

type		status	case	RATINGS $I_{F(AV)}$	I_{FWM}	V_{RRM}	I_{FRM}	CHARACTERISTICS t_d min	t_{tot} max	t_{rr} max
				A	A	V	A	µs	µs	ns
BY188A		D	SOD-18	1,2	–	50	10	0	–	–
BY188B								0,7		
BY223		D	SOD-38	–	5	1500	10	–	20	–
BY277	– 600R	D	SOD-38	–	10	600	20	–	–	400
	– 750R					750				

rectifier diodes

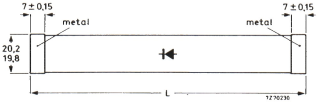
abridged data

Normal polarity (cathode to stud) **no end-letter**
Reverse polarity (anode to stud) **R**
Both polarities available **(R)**

Avalanche

type	status	case	RATINGS $I_{F(AV)}$ A	V_{RWM} V	I_{FRM} A	I_{FSM} and I^2t T_{jmax}; t = 10 ms A	A²s	P_{RRM} t = 10 μs kW	P_{RSM} kW	CHARACTERISTICS I_{Rmax} $T_j \geqslant 125$ °C mA
BYX45 – 600R – 800R –1000R	C	DO-1	**1,5**	600 800 1000	15	40	8	0,8	0,8	0,1
BYW54 – 600 **BYW55** – 800 **BYW56** –1000	N	SOD-57	**2**	600 800 1000	12	50	–	–	1	0,0005 (T_j = 25 °C)
BYX39 – 600(R) – 800(R) –1000(R)	D	DO-4(1)	**9,5**	600 800 1000	100	85	50	2	0,8	0,15
BYX25 – 600(R) – 800(R) –1000(R)	C	DO-4(2)	**20**	600 800 1000	440	550	1500	3	3	1 0,8 0,6
BYX56 – 600(R) – 800(R) –1000(R)	C	DO-5(1)	**47**	600 800 1000	450	800	3200	6,5	6,5	1,6

E.H.T. rectifiers

type	status	case	leads	$I_{F(AV)}$ max mA	V_{RRM} max kV	for use in
BY184	C	SOD-34(1)	long	5	1,8	colour tv V_{g2} supply
BY209	C	SOD-34(2)	medium	2,5	12,5	colour tv and tripler circuits
BY409 **BY409/01**	D	SOD-34(1) SOD-34(2)	long medium	2,5*	12,5	high-voltage multipliers and colour tv
BY476 **BY476/01**	D	SOD-56	min 22 mm min 13 mm	2,5	18	high-voltage multipliers, tiny vision and black-and-white tv
BY477 **BY478**	N	SOD-56		2	23 27,5	high-voltage rectifiers for black-and-white tv
BYX90	D	SOD-18		200	7,5	main application in sub-assembly (BYX91) for X-ray equipment
BYX35	C	SOD-29		50	37,5	X-ray apparatus
BYX91 – 90K –120K –150K –180K	D	L = max 143 mm L = max 171 mm L = max 231 mm L = max 231 mm		200	115 150 190 225	X-ray apparatus  7 ± 0,15 7 ± 0,15 metal metal 20,2 19,8 L 7Z70230

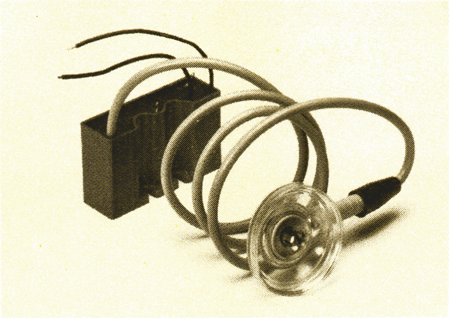
* 4 mA up to T_{amb} = 77 °C, as clamping diode in tripler circuits.

Voltage tripler units

type	status	case sizes in mm	T_{amb} max °C	RATINGS INPUT $V_{i(p\text{-}p)}$ kV	OUTPUT $V_{O(EHT)}$ kV	$I_{O(EHT)}$ mA	$I_{O(FOC)}$ μA
BG1895 –541 –641	D	25,5 x 75 x 45	65	10	27,5	1,7	400

Fast-recovery diodes

Use in h.f. power supplies
inverters
multi-phase rectifiers
pulse height detectors
clamp circuits
scan circuits — tv deflection



Voltage tripler units.
Non-flammable units for e.h.t. supply in colour tv.
BG1895—541 for hybrid and —641 for all-transistor receivers.

Fast soft-recovery

type		status	case	RATINGS $I_{F(AV)}$ A	V_{RRM} V	V_{RWM} V	I_{FRM} A	I_{FSM} and T_{jmax}; t = 10 ms A	I^2t A^2s	CHARACTERISTICS t_{rr} max ns	V_{Fmax} at I_F $T_j = 25$ °C V	 A	I_{Rmax} $T_j \geqslant 125$ °C mA
BY206 **BY207**		D	DO-14	**0,4**	350 600	300 500	3*	15	—	300	1,55	2	0,200 0,125
BY208	— 600 — 800 —1000	D	DO-15	**0,75**	600 800 1000	400 600 800	5	20	—	350	1,8	2	0,08
BY406 **BY407**		D	DO-15	**0,8**	350 600	300 500	5	15	—	300	1,55	2	0,200 0,125
BYX55	— 350 — 600	D	SOD-18	**1,2**	350 600	300 500	8	40	—	350	1,25	5	0,75
1N3880 **1N3881** **1N3882**	— 100(R) — 200(R) — 300(R)	D	DO-4(1)	**6**	100 200 300	100 200 300	75	75	28	200	1,4	6	3
BYW19	— 800(R) —1000(R)	D	SOD-38	**7**	800 1000	800 800	65	40	—	450	2,3	20	0,6
BYX50	— 200(R) — 300(R)	D	DO-4(1)	**7**	200 300	200 300	80	80	32	100	1,95	20	3
BYX71	— 350(R) — 600(R)	D	SOD-38	**7**	350 600	300 500	25	60	—	450	1,25	5	0,4
1N3890 **1N3891** **1N3892**	— 100(R) — 200(R) — 300(R)	D	DO-4(1)	**12**	100 200 300	100 200 300	140	140	100	200	1,4	12	3
BYX30	— 200(R) — 300(R) — 400(R) — 500(R) — 600(R)	C C D D D	DO-4(2)	**14**	— — —	200 300 400 500 600	310	250	325	350	3,2	50	4
BYX46	— 200(R) — 300(R) — 400(R) — 500(R) — 600(R)	D	DO-4(2)	**22**	— — — — —	200 300 400 500 600	400	300	400	350	2	50	4

Very fast recovery

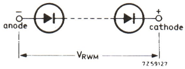
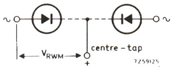
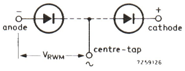
$T_j \leqslant 100$ °C

BYW29	— 50 — 100 — 150	D	see cases	**7**	50 100 150	50 100 150	80	80	32	35	0,85	5	0,6
BYW30	— 50 — 100 — 150	D	DO-4(1)	**12**	50 100 150	50 100 150	200	200	200	35	0,85	10	1,3
BYW31	— 50 — 100 — 150	D	DO-4(2)	**25**	50 100 150	50 100 150	320	320	500	50	0,85	20	2,5
BYW92	— 50 — 100 — 150	N	DO-5(2)	**35**	50 100 150	50 100 150	320	320	500	50	0,95	35	2,5

* $\delta \leqslant 0{,}03$; f ⩾ 15 kHz; $I_{FRM} = 5$ A.

rectifier stacks

E.H.T. power rectifiers

type	status	$I_{F(AV)}$	V_{RWM}	for use in	
OSS9110 - 3 to -30	D	3,5 A (6 A in oil)	3 kV to 30 kV	single-phase rectifiers	
OSS9210 - 3 to -30		5 A (20 A in oil)			
OSS9310 - 3 to -30		4 A (12 A in oil)			
OSS9410 - 3 to -30		10 A (30 A in oil)			
OSB9110 - 4 to -30	D	7 A (12 A in oil)	2 kV to 15 kV	two-phase half-wave circuits	
OSB9210 - 4 to -30		10 A (40 A in oil)			
OSB9310 - 4 to -30		8 A (24 A in oil)			
OSB9410 - 4 to -30		20 A (60 A in oil)			
OSM9110- 4 to -30	D	3,5 A (6 A in oil)	2 kV to 15 kV	bridges and voltage doublers, single or three-phase	
OSM9210- 4 to -30		5 A (20 A in oil)			
OSM9310- 4 to -30		4 A (12 A in oil)			
OSM9410- 4 to -30		10 A (30 A in oil)			

−
anode
+
cathode
VRWM
7Z59127

~
~
centre - tap
VRWM
+
7Z59125

−
anode
+
cathode
centre-tap
VRWM
~
7Z59126

transient suppressor diodes

- standard or custom specifications
- standardized cases
- P_{RSM} up to 120 kW for 10 µs or 60 kW for 100 µs
- small handy cases can replace coil and capacitor suppressors

Normal polarity (cathode to stud)	**no end-letter**
Reverse polarity (anode to stud)	**R**
Both polarities available	**(R)**

Series number	**BZW70– . . .**	**BZW93– . . . (R)**	**BZW91– . . . (R)**	**BZW86– . . . (R)**
P_{RSM}, t_p = 100 µs (kW)	**3**	**3**	**27**	**60**
P_{RRM}, t_p = 10 µs (kW)	2,5	3	25	50
at T_{mb} (°C)	65	65	65	65
Case	SOD-18	DO-4(1)	DO-5(1)	DO-30
Status	D	D	D	D

reverse breakdown voltage in volts at T_j = 25 °C

Type number suffix (is stand-off voltage)		BZW70– . . .		BZW93– . . . (R)		BZW91– . . . (R)		BZW86– . . . (R)
5V6	**50**	6,4	**2A**	6,4				
6V2		7,0		7,0		7,0		
6V8		7,7		7,7		7,7		
7V5		8,5	**1A**	8,5	**2A**	8,5	**10A**	8,5
8V2		9,4		9,4		9,4		9,4
9V1		10,4		10,4		10,4		10,4
10		11,4		11,4		11,4		11,4
11		12,4		12,4		12,4		12,4
12		13,8		13,8		13,8		13,8
13	**20**	15,3	**500**	15,3		15,3		15,3
15		16,8		16,8		16,8		16,8
16		18,8		18,8	**1A**	18,8	**5A**	18,8
18		20,8		20,8		20,8		20,8
20		22,8		22,8		22,8		22,8
22		25,1		25,1		25,1		25,1
24		28		28		28		28
27		31		31		31		31
30		34	**200**	34		34		34
33	**10**	37		37	**500**	37	**2A**	37
36		40		40		40		40
39		44		44		44		44
43		48		48		48		48
47		52		52		52		52
51		58		58		58		58
56		64		64		64		64
62		70		70		70		70

current in mA (< 1 A) or A (≥ 1 A) at which breakdown voltage is specified

Transient suppressor bridge

type	status	case	V_I V	$V_{(CL)R}$ V	$I_{(CL)SM}$ A
BZW10	N	SOD-28	12	30	50

thyristors and triacs

selection guide

General purpose thyristors (pages A25/A26)

$I_{T(AV)max}$		V_{RRMmax} (V)											
A		100	200	300	400	500	600	650	800	1000	1200	1400	1600
1	BTX18	●	●	●	●	●							
7,5	BT151					●		●					
10	BTY79				●	●	●		●	●			
10	BTW38						●		●	●	●		
10	BTW42						●		●	●	●		
16	BTW45				●		●		●	●	●		
16	BTW47								●	●	●	●	●
16	BTY87				●	●	●		●				
16	BTY91				●	●	●		●				
20	BTW40				●		●		●				
20	BTW92								●	●	●	●	●
35	BTW24						●		●	●	●	●	●
90	BTW23						●		●	●	●	●	●

Fast turn-off thyristors (page A27)

$I_{T(AV)max}$		V_{DRMmax} (V)						
A		600	650	800	1000	1200	1400	1600
16	BTW30	●		●	●			
22	BTW31	●		●	●			
80	BTW33	●		●	●			

Triacs (page A28/A29)

$I_{T(RMS)max}$		V_{DRMmax} (V)								
A		400	500	600	650	800	1000	1200	1400	1600
6	BT137		●	●						
10	BT138		●	●						
15	BT139		●	●						
15	BTW43G			●		●	●	●		
15	BTW43H			●		●	●	●		
25	BTX94H	●		●		●	●	●		
25	BTX94J	●		●		●	●	●		
40	BTW41G		●	●		●				
40	BTW41H		●	●		●				
55	BTW34G			●		●	●	●	●	●
55	BTW34H			●		●	●	●	●	●

Thyristor tetrode (page A27) BRY39 V_{RRMmax} = 70 V; I_{Tmax} = 250 mA

thyristors

abridged data

Normal polarity (cathode to stud)	no end-letter
Reverse polarity (anode to stud)	R
Both polarities available	(R)

General purpose (The type number suffix is the V_{RRM}-rating)

				RATINGS						CHARACTERISTICS			
type		status	case	$I_{T(AV)}$ A	$I_{T(RMS)}$ A	I_{TRM} A	I_{TSM} and $T_{j\ max}$; A	I^2t 10 ms A^2s	dI_T/dt A/μs	dV_D/dt max * V/μs	I_R ** max mA	V_{GT}▲ min V	I_{GT}▲ min mA
BTX18	– 100 – 200 – 300 – 400 – 500	D	TO-39(2)	**1**	1,6	10	10	–	–	15	0,8 0,4 0,275 0,2 0,16	2	5
BT151	– 500R – 650R	N	TO-220AB(3)	**7,5**	12	15	100	50	50	50	0,5	1,5	15
BTY79	– 400R – 500R – 600R – 800R –1000R	D	TO-64	**10**	16	75	150	112	50	50	3	2,5	30
BTW38	– 600R – 800R –1000R –1200R	D	TO-64	**10**	14	75	150	112	50	50	3	1,5	50
BTW42	– 600R – 800R –1000R –1200R	D	TO-64	**10**	16	75	150	112	50	200	3	1,5	50
BTW45	– 400R – 600R – 800R –1000R –1200R	D	TO-48	**16**	25	200	300	450	100	200	3	1,5	75
BTW47	– 800R –1000R –1200R –1400R –1600R	C	TO-48	**16**	25	150	300	450	200	300 ▲▲	5	3,5	100
BTY87	– 400R – 500R – 600R – 800R	C	TO-48	**16**	25	140	140	100	20	20	3	3,5	65
BTY91	– 400R – 500R – 600R – 800R	C	TO-48	**16**	25	200	200	200	20	20	3	3	40

* At $T_j = T_{j\ max}$.

** $I_R = I_D$; at working temperature; $V_R = V_{RWMmax}$; $V_D = V_{DWMmax}$.

▲ $V_D = 6$ V, $T_j = 25$ °C.

▲▲ Up to 1000 V/μs on request.

thyristors

abridged data

Normal polarity (cathode to stud)	**no end-letter**
Reverse polarity (anode to stud)	**R**
Both polarities available	**(R)**

General purpose (The type number suffix is the V_{RRM}-rating)

type	status	case	RATINGS $I_{T(AV)}$ A	$I_{T(RMS)}$ A	I_{TRM} A	I_{TSM} and T_{jmax}; A	I^2t 10 ms kA^2s	dI_T/dt A/µs	CHARACTERISTICS dV_D/dt* max V/µs	I_R** max mA	V_{GT}▲ min V	I_{GT}▲ min mA
BTW40 – 400R – 600R – 800R	D	TO-48	**20**	32	200	400	0,8	100	100	3	1,5	75
BTW92 – 800R –1000R –1200R –1400R –1600R	D	TO-48	**20**	31	200	400	0,8	300	300▲▲	5	3,5	100
BTW24 – 600R – 800R –1000R –1200R –1400R –1600R	D	TO-103	**35**	55	450	800	3,2	300	200▲▲	10	2,5	100
BTW23 – 600R – 800R –1000R –1200R –1400R –1600R	D	TO-94	**90**	140	1250	2000	20	300	200▲▲	15	2,5	150

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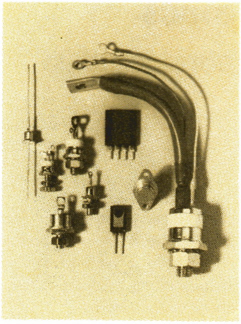
* At $T_j = T_{j\,max}$.

** $I_R = I_D$; at working temperature; $V_R = V_{RWMmax}$; $V_D = V_{DWMmax}$.

▲ $V_D = 6$ V, $T_j = 25$ °C.

▲▲ Up to 1000 V/µs on request.



Fast turn-off thyristors for motor control and 3-phase inverters. Excellent dI_T/dt and dV_D/dt ratings mean fewer protection components.

For use in high-frequency applications such as
- choppers
- pulse circuits
- frequency converters
- d.c. supplies

Fast turn-off (The type number suffix is the V_{RRM}-rating)

type	status	case	RATINGS $I_{T(AV)}$ A	 $I_{T(RMS)}$ A	 I_{TRM} A	 I_{TSM} and T_{jmax}; A	 I^2t 10 ms kA²s	 dI_T/dt A/µs	CHARACTERISTICS t_q max µs	 dV_D/dt* max V/µs	 I_D** max mA	 V_{GT}▲ min V	 I_{GT}▲ min mA
BTW30 – 600R – 800R –1000R	D	TO-48	**16**	24	150	150	0,115	100	15	200	7	2,5	200
BTW31 – 600R – 800R –1000R	D	TO-48	**22**	31	240	240	0,29	100	20	200	7	2,5	200
BTW33 – 600R – 800R –1000R	D	TO-94	**80**	110	750	1500	11,25	100	15▲▲	200	25	2,5	150

trigger device

Thyristor tetrode

type	status	case	RATINGS V_D V_R V	 I_{TSM}* t = 10 µs A	 I_T mA	 dI_T/dt A/µs	CHARACTERISTICS at $T_j = 25\ ^\circ C$ V_{GKT} min V	 I_{GKT} min µA	 V_{GAT} min V	 I_{GAT} min µA
BRY39	D	TO-72(3)	70	3	250	20	0,5	1	–1	–100

* At $T_j = T_{j\,max}$.

** At working temperature; $V_D = V_{DWMmax}$

▲ $V_D = 6$ V, $T_j = 25\ ^\circ C$.

▲▲ 10 µs on request.

triacs

abridged data

High quality triacs for motor control, furnace control, heating, light dimming, contactor drive, static switching, etc. They have a high surge capability and, due to the high commutating characteristics, are excellent for use with three-phase systems.

Triacs (The type number suffix is the V_{DRM}-rating)

type		status	case	RATINGS $I_{T(RMS)}$	I_{TRM}	I_{TSM} and I^2t T_j max; 10 ms		dI_T/dt	CHARACTERISTICS dV_D/dt max at T_j max			V_{GT}▲	I_{GT}▲
									normal	commutating	at $-dI_T/dt$	min	min
				A	A	A	A^2s	A/µs	V/µs	V/µs	A/ms	V	mA
BT137	– 500 – 600	N	TO-220AB(2)	**6**	55	55	15	20	50	6	5	1,5 1,5 – 1,5 – 1,5	35 60 – 35 – 35
BT138	– 500 – 600	D	TO-220AB(2)	**10**	90	90	40	30	50	4	5	1,5 1,5 – 1,5 – 1,5	35 50 – 35 – 35
BT139	– 500 – 600	D	TO-220AB(2)	**15**	115	115	65	30	50	4	8	1,5 1,5 – 1,5 – 1,5	35 50 – 35 – 35

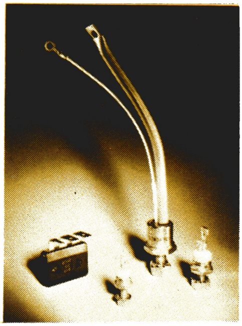
▲ $V_D = 12$ V; $T_j = 25$ °C.

The four values shown for V_{GT} and I_{GT} apply to the following conditions:

first: T_2 positive; G positive.
second: T_2 negative; G positive.
third: T_2 positive; G negative.
fourth: T_2 negative; G negative.

Letters G, H or J are added to the main type number to indicate the dI_T/dt value at which the specified dV_{com}/dt max occurs.

G: dV_{com}/dt max at −dI_T/dt = 0,5 x $I_{T(RMS)}$ rating per ms
H: at −dI_T/dt = 1 x $I_{T(RMS)}$ rating per ms
J: at −dI_T/dt = 2 x $I_{T(RMS)}$ rating per ms



Triacs (The type number suffix is the V_{DRM}-rating)

				RATINGS					CHARACTERISTICS				
type		status	case	$I_{T(RMS)}$ A	I_{TRM} A	I_{TSM} and I^2t T_j max; 10 ms A	A²s	dI_T/dt A/µs	dV_D/dt max at T_j max normal V/µs	commutating at −dI_T/dt V/µs	A/ms	V_{GT}▲ min V	I_{GT}▲ min mA
BTW43G	– 600 – 800 –1000 –1200	D	TO-64	**15**	50	120	72	50	50	10	5	2,5 5,0 – 2,5 – 2,5	100 200 – 100 – 100
BTW43H	– 600 – 800 –1000 –1200	D	TO-64	**15**	50	120	72	50	50	10	12	2,5 5,0 – 2,5 – 2,5	100 200 – 100 – 100
BTX94H	– 400 – 600 – 800 –1000 –1200	D	TO-48	**25**	100	250	320	50	100	30	25	3 5 – 3 – 3	150 200 – 150 – 150
BTX94J	– 400 – 600 – 800 –1000 –1200	D	TO-48	**25**	100	250	320	50	100	30	50	3 5 – 3 – 3	150 200 – 150 – 150
BTW41G	– 500 – 600 – 800	D	SOT-80	**40**	100	260	340	50	100	5	12	1,5 3 – 1,5 – 1,5	75 150 – 75 – 75
BTW41H	– 500 – 600 – 800	D	SOT-80	**40**	100	260	340	50	100	5	23	1,5 3 – 1,5 – 1,5	75 150 – 75 – 75
BTW34G	– 600 – 800 –1000 –1200 –1400 –1600	D	TO-103	**55**	300	400	800	50	200	30	25	2,5 – – 2,5 – 2,5	200 – – 200 – 200
BTW34H	– 600 – 800 –1000 –1200 –1400 –1600	D	TO-103	**55**	300	400	800	50	200	30	50	2,5 – – 2,5 – 2,5	200 – – 200 – 200

▲ see page A28

complete transistor guide

P

P listed by power dissipation
V listed by voltage

N = n-p-n
P = p-n-p
F = FET
M = MOS-FET

P_{tot} max W		V_{CEO} V_{DS} max V	type no.	page
0,03	N	5	BFT24	A51
	N		BFT25	A68
0,05	N	20	BC146	A42
	P		BC200	A43
0,06	P	15	AF367	A50
0,1	P	13	AF379	A50
0,12	N	20	BF362	A50
	N		BF363	A50
0,14	N	15	BF480	A50
0,145	N	30	BF115	A50
	N	20	BF184	A50
	N		BF185	A50
0,15	N	12	BFQ22	A65
	P		BFQ24	A65
	N	20	BF180	A50
	N		BF181	A50
	N		BF182	A50
	N		BF183	A50
	N		BF200	A50
	F	30	BFW12	A56
	F		BFW13	A56
	N	40	BCY87	A58
	N		BCY88	A58
	N		BCY89	A58
0,16	P	20	BF979	A50
	P	25	BF939	A50
	P	30	BF967	A50
0,18	N	10	BFR53	A68
	P	12	BFQ23	A65
	N		BFR91	A65
	N		BFR93	A68
	P		BFT93	A68
	N	15	BFR49	A65

P_{tot} max W		V_{CEO} V_{DS} max V	type no.	page
0,18	N	15	BFR90	A65
cont.	N		BFR92	A68
	P		BFT92	A68
0,19	N	10	BFW93	A65
	N	15	BFW92	A65
0,2	N	12	BSV52	A69
	N	15	BFS17	A68
	N		BFX89	A65
	N		BFY90	A65
	P		BSR12	A69
	N		2N918	A51
	P	20	BCW29	A67
	P		BCW30	A67
	N		BCW31	A67
	N		BCW32	A67
	N		BCW33	A67
	N		BFS18	A68
	N		BFS19	A68
	N		BFS20	A68
	M		BFS28	A56
	F	25	BFR30	A69
	F		BFR31	A69
	M	30	BFR29	A56
	M		BSV81	A57
	P	45	BCW69	A67
	P		BCW70	A67
	N		BCW71	A67
	N		BCW72	A67
	N	80	BSS64	A69
	P	100	BSS63	A69
0,225	M	20	BF327	A56
0,25	N	10	BFW30	A65
	N	20	BF194	A50
	N		BF195	A50
	P		BF936	A50
	N	25	BF197	A50
	N	30	BF196	A50
	P		BF324	A50
	F		BFQ10	A58

P_{tot} max W		V_{CEO} V_{DS} max V	type no.	page
0,25	F	30	BFQ11	A58
cont.	F		BFQ12	A58
	F		BFQ13	A58
	F		BFQ14	A58
	F		BFQ15	A58
	F		BFQ16	A58
	N	40	BF240	A50
	N		BF241	A50
	P		BF450	A50
	P		BF451	A50
0,3	N	20	BC108	A42
	N		BC109	A42
	N		BC148	A42
	N		BC149	A42
	P		BC159	A42
	P		BC179	A42
	N		BCY57	A44
	N		BF494	A50
	N		BF495	A50
	M		BFR84	A56
	P	25	BC158	A42
	P		BC178	A42
	F		BF246	A56
	F		BFW61	A56
	F	30	BC264	A56
	F		BF245	A56
	F		BF256	A56
	F		BFS21	A58
	F		BFS21A	A58
	F		BFW10	A56
	F		BFW11	A56
	F		2N3823	A56
	F		2N3966	A57
	N	45	BC107	A42
	N		BC147	A42
	P		BC157	A42
	P		BC177	A42
	N		BCY56	A44
	N		2N929	A47
	N		2N930	A47
	N	80	BSX21	A54

P

P_{tot} max W		V_{CEO} V_{DS} max V	type no.	page
0,31	P	25	BCX18	A67
	N		BCX20	A67
	P	45	BCX17	A67
	N		BCX19	A67
0,34	N	12	AC127	A42
0,345	P	32	BCY78	A44
	P	45	BCY79	A44
0,35	P	25	BCY72	A44
	P	40	BCY70	A44
	F		BSV78	A57
	F		BSV79	A57
	F		BSV80	A57
	P	45	BCY71	A44
0,36	P	12	2N2894	A55
	P		2N2894A	A55
	N	15	BSX19	A54
	N		BSX20	A54
	N		2N2368	A55
	N		2N2369	A55
	N		2N2369A	A55
	F	30	2N4859	A57
	F		2N4860	A57
	F		2N4861	A57
	F	40	2N4856	A57
	F		2N4857	A57
	F		2N4858	A57
	N	60	2N2483	A47
	N		2N2484	A47
0,4	P	40	2N2906	A55
	P		2N2907	A55
	P	60	2N2906A	A55
	P		2N2907A	A55
0,5	P	12	AC125	A42
	P		AC126	A42
	P		AC132	A42
	N	15	BFQ19	A68
0,5	P	15	BFQ32	A65
cont.	N		BFR96	A65
	N	25	BF199	A50
	N	30	BC548	A43
	N		BC549	A43
	P		BC558	A43
	P		BC559	A43
	N		BF198	A50
	N		2N2221	A55
	N		2N2222	A55
	N	40	2N2221A	A55
	N		2N2222A	A55
	N	45	BC547	A43
	N		BC550	A43
	P		BC557	A43
	P		BC560	A43
	N	65	BC546	A43
	P		BC556	A43
	N	100	BSS38	A54
	P		BSS68	A54
0,6	P	32	BCY33A	A44
	P		BCY34A	A44
	P	40	2N2904	A55
	P		2N2905	A55
	P	60	2N2904A	A55
	P		2N2905A	A55
	P	64	BCY30A	A44
	P		BCY31A	A44
	P		BCY32A	A44
0,8	N	20	BFY52	A51
	P	25	BC328	A43
	N		BC338	A43
	N	30	BFY51	A51
	N		BSX60	A54
	N		2N2218	A55
	N		2N2219	A55
	N	35	BFY50	A51
	N		BFY55	A51
	N		2N2297	A51
	P	40	BSV15	A54
0,8	N	40	2N2218A	A55
cont.	N		2N2219A	A55
	P	45	BC327	A43
	N		BC337	A43
	N		BSR50	A54
	N		BSS50	A54
	P		BSS60	A54
	N		BSX59	A54
	N		BSX61	A54
	N	50	2N1613	A51
	N		2N1711	A51
	N		BSR51	A54
	N	60	BSS51	A54
	P		BSS61	A54
	P		BSV16	A54
	P		2N4030	A51
	P		2N4032	A51
	N	80	BSS52	A54
	P		BSV17	A54
	N		2N1893	A51
	N		2N3019	A55
	N		2N3020	A55
	P		2N4031	A51
	P		2N4033	A51
	N	100	BSW66	A54
	N	120	BSW67	A54
	N	130	BFW45	A51
	N	150	BSW68	A54
0,83	N	250	BF422	A50
	P		BF423	A50
0,87	N	60	BFX34	A54
1	N	15	AC187	A42
	P		AC188	A42
	P	16	AC128	A42
	N	20	BC368	A43
	P		BC369	A43
	N	25	BSW41A	A54
	N		BFQ17	A68
	N		BFQ18	A68

complete transistor guide

P

P listed by power dissipation
V listed by voltage

N = n-p-n
P = p-n-p
F = FET
M = MOS-FET

P_{tot} max W		V_{CEO} V_{DS} max V	type no.	page
1	N	32	BCY58	A44
cont.	N	45	BC635	A43
	P		BC636	A44
	P		BCX51	A67
	N		BCX54	A67
	N		BCY59	A44
	N	60	BC637	A43
	P		BC638	A44
	P		BCX52	A67
	N		BCX55	A67
	N	80	BC639	A43
	P		BC640	A44
	P		BCX53	A67
	N		BCX56	A67
	P	200	2N5415	A55
	N	250	BF622	A69
	P		BF623	A69
	P	300	2N5416	A55
1,5	N	25	BFR95	A65
	N		BFW16A	A65
	N		BFW17A	A65
1,8	F	40	2N4091	A57
	F		2N4092	A57
	F		2N4093	A57
	F		2N4391	A57
	F		2N4392	A57
	F		2N4393	A57
	N	250	BF469	A50
	P		BF470	A50
2,25	N	18	BF934	A65
2,5	N	25	BFR94	A65
3	N	18	BLX65	A62
	N	180	BF336	A50
	N	200	BF337	A50
	N	225	BF338	A50
3,5	N	20	2N4427	A62
	N	25	BFR64	A65
3,7	N	40	BC140	A42
	P		BC160	A42
	N	60	BC141	A42
	P		BC161	A42
4	N	18	BLX66	A62
	N	33	BLX91A	A63
4,5	N	18	BLX67	A62
5	N	25	BFR65	A65
	N	30	2N3866	A63
	N		BLW32	A60
	N	40	BSX45	A54
	N	60	BSV64	A54
	N		BSX46	A54
	P	65	2N4036	A55
	N	80	BSX47	A54
	P	250	BFT45	A51
	P	300	BFT44	A51
6	N	33	BLX92A	A63
	N	160	BF457	A50
	N	180	BD115	A44
	N	250	BF458	A50
	N	300	BF459	A50
6,25	N	27	BLX96	A60
6,75	N	18	BFQ42	A62
7	N	18	2N3924	A62
	N	40	2N3553	A63
8	N	18	BFS22A	A62
	N	36	BFS23A	A63
	N	45	BD135	A44
	P		BD136	A44
	N	60	BD137	A44
8	P	60	BD138	A44
cont.	N	80	BD139	A44
	P		BD140	A44
8,5	N	17	BLW79	A62
10	N	18	BFQ43	A62
	N		BLX68	A62
	N	30	BLW33	A60
	N	600	BU204	A47
	N	700	BU205	A47
	N	800	BU206	A47
11,6	N	18	2N3926	A62
	N	40	2N3375	A63
12,5	N	27	BLX97	A60
	N	33	BLX93A	A63
	N	45	BD226	A44
	P		BD227	A45
	N	60	BD228	A44
	P		BD229	A45
	N	80	BD230	A44
	P		BD231	A45
	N	600	BU207A	A47
	N	700	BU208A	A47
	N	800	BU209A	A47
15	N	20	BD329	A45
	P		BD330	A45
	N	45	BD131	A44
	P		BD132	A44
	N	60	BD133	A44
	N	300	BD232	A45
17	N	17	BLW80	A62
17,5	N	18	BLY87A	A62
	N		BLY87C	A62
	N	30	BLW34	A60
	N	36	BLY91A	A63

P_{tot} max W		V_{CEO} V_{DS} max V	type no.	page
18	N	36	BLY91C	A63
20	N	400	BUX86	A47
	N	450	BUX87	A47
21,5	N	27	BLW98	A60
	N		BLX98	A60
23	N	18	2N3927	A62
	N	40	2N3632	A63
25	N	45	BD233	A45
	P		BD234	A45
	N	60	BD235	A45
	P		BD236	A45
	N	80	BD237	A45
	P		BD238	A45
30	N	250	BU133	A47
	N		BU126	A47
32	N	18	BLY88A	A62
	N		BLY88C	A62
	N	36	BLY92A	A63
	N		BLY92C	A63
36	N	22	BD433	A45
	P		BD434	A45
	N	32	BD435	A45
	P		BD436	A45
	N	45	BD437	A45
	P		BD438	A45
40	N	17	BLW81	A62
	N	32	BLW64	A60
	N	45	BD675	A46
	P		BD676	A46
	N	60	BD677	A46
	P		BD678	A46
	N		BDY92	A47
	N	80	BD679	A46
	P		BD680	A46
	N		BDY91	A47
	N	100	BD681	A46
	P		BD682	A46
	N		BDY90	A47
	N	400	BUX84	A47
	N	450	BUX85	A47
45	N	18	BLW29	A62
50	N	18	BLX69A	A62
	N	30	BLX94A	A63
	N	36	BLX39	A63
60	N	32	BLW75	A60
	N	45	BD201	A44
	P		BD202	A44
	N		BD291	A45
	P		BD292	A45
	N	60	BD203	A44
	P		BD204	A44
	N		BD293	A45
	P		BD294	A45
	N		BD331	A45
	P		BD332	A45
	N	80	BD333	A45
	P		BD334	A45
	N		BDX77	A46
	P		BDX78	A46
	N	100	BD335	A45
	P		BD336	A45
	N	400	BU326A	A47
	N		BUX82	A47
	N	450	BUX83	A47
62,5	N	36	BLX13	A63
	N	60	BD645	A45
	P		BD646	A45
	N	80	BD647	A45
	P		BD648	A45
	N	100	BD649	A45
	P	100	BD650	A45
	N	120	BUY86	A54
	N	150	BUY87	A54
	N		BUY88	A54
65	N	18	BLW60	A62
70	N	18	BLW31	A62
	N		BLW82	A62
	N		BLY89A	A62
	N	36	BLX13C	A63
	N		BLY93A	A63
	N		BLY93C	A63
	N	375	BUY26	A47
73	N	18	BLY89C	A62
76	N	18	BLW87	A62
	N	30	BLX95	A63
	N	36	BLW83	A63
	N		BLW84	A63
88	N	36	BLX14	A63
90	P	60	BDX62	A46
	N		BDX63	A46
	N		BDX91	A47
	P		BDX92	A47
	P	80	BDX62A	A46
	N		BDX63A	A46
	N		BDX93	A47
	P		BDX94	A47
	P	100	BDX62B	A46
	N		BDX63B	A46
	N		BDX95	A47
	P		BDX96	A47
100	N	18	BLW60C	A62
	N	400	BUX80	A47
	N	450	BUX81	A47
105	N	18	BLW85	A62
	N	36	BLW86	A63
117	P	60	BDX64	A46
	N		BDX65	A46
	P	80	BDX64A	A46
	N		BDX65A	A46
	P	100	BDX64B	A46
	N		BDX65B	A46
	P	120	BDX64C	A46
	N		BDX65C	A46
125	P	60	BDV64	A46
	N		BDV65	A46
	P	80	BDV64A	A46
	N		BDV65A	A46
	P	100	BDV64B	A46
	N		BDV65B	A46
130	N	18	BLY90	A62
	N	36	BLY94	A63
140	N	35	BLW76	A63
150	P	60	BDX66	A46
	N		BDX67	A46
	P	80	BDX66A	A46
	N		BDX67A	A46
	P	100	BDX66B	A46
	N		BDX67B	A46
160	N	35	BLW78	A63
195	N	53	BLX15	A63
245	N	35	BLW77	A63

P listed by power dissipation
V listed by voltage

N = n-p-n
P = p-n-p
F = FET
M = MOS-FET

V_{CEO} V_{DS} max V		P_{tot} max W	type no.	page
5	N	0,03	BFT24	A51
	N		BFT25	A68
10	N	0,18	BFR53	A68
	N	0,19	BFW93	A65
	N	0,25	BFW30	A65
12	N	0,15	BFQ22	A65
	P		BFQ24	A65
	P	0,18	BFQ23	A65
	N		BFR91	A65
	N		BFR93	A68
	P		BFT93	A68
	N	0,2	BSV52	A69
	N	0,34	AC127	A42
	P	0,36	2N2894	A55
	P		2N2894A	A55
	P	0,5	AC125	A42
	P		AC126	A42
	P		AC132	A42
13	P	0,1	AF379	A50
15	P	0,06	AF367	A50
	N	0,14	BF480	A50
	N	0,18	BFR49	A65
	N		BFR90	A65
	N		BFR92	A68
	P		BFT92	A68
	N	0,19	BFW92	A65
	N	0,2	BFS17	A68
	N		BFX89	A65
	N		BFY90	A65
	P		BSR12	A69
	N		2N918	A51
	N	0,36	BSX19	A54
	N		BSX20	A54
	N		2N2368	A55
	N		2N2369	A55
	N		2N2369A	A55
	N	0,5	BFQ19	A68
	P		BFQ32	A65
15	N	0,5	BFR96	A65
cont.	N	1	AC187	A42
	P		AC188	A42
16	P	1	AC128	A42
17	N	8,5	BLW79	A62
	N	17	BLW80	A62
	N	40	BLW81	A62
18	N	2,25	BFQ34	A65
	N	6,75	BFQ42	A62
	N	7	2N3924	A62
	N	8	BFS22A	A62
	N	10	BFQ43	A62
	N		BLX68	A62
	N	11,6	2N3926	A62
	N	17,5	BLY87A	A62
	N		BLY87C	A62
	N	23	2N3927	A62
	N	32	BLY88A	A62
	N		BLY88C	A62
	N	45	BLW29	A62
	N	50	BLX69A	A62
	N	65	BLW60	A62
	N	70	BLW31	A62
	N		BLW82	A62
	N		BLY89A	A62
	N	73	BLY89C	A62
	N	76	BLW87	A62
	N	100	BLW60C	A62
	N	105	BLW85	A62
	N	130	BLY90	A62
20	N	0,05	BC146	A42
	P		BC200	A43
	N	0,12	BF362	A50
	N		BF363	A50
	N	0,145	BF184	A50
	N		BF185	A50
	N	0,15	BF180	A50
	N		BF181	A50
20	N	0,15	BF182	A50
cont.	N		BF183	A50
	N		BF200	A50
	P	0,16	BF979	A50
	P	0,2	BCW29	A67
	P		BCW30	A67
	N		BCW31	A67
	N		BCW32	A67
	N		BCW33	A67
	N		BFS18	A68
	N		BFS19	A68
	N		BFS20	A68
	M		BFS28	A56
	M	0,225	BF327	A56
	N	0,25	BF194	A50
	N		BF195	A50
	P		BF936	A50
	N	0,3	BC108	A42
	N		BC109	A42
	N		BC148	A42
	N		BC149	A42
	P		BC159	A42
	P		BC179	A42
	N		BCY57	A44
	N		BF494	A50
	N		BF495	A50
	M	0,3	BFR84	A56
	N	0,8	BFY52	A51
	N	1	BC368	A43
	P		BC369	A43
	N	3,5	2N4427	A62
	N	15	BD329	A45
	P		BD330	A45
22	N	36	BD433	A45
	P		BD434	A45
25	P	0,16	BF939	A50
	F	0,2	BFR30	A69
	F		BFR31	A69
	N	0,25	BF197	A50
	P	0,3	BC158	A42

V_{CEO} V_{DS} max V		P_{tot} max W	type no.	page
25 cont.	P	0,3	BC178	A42
	F		BF246	A56
	F		BFW61	A56
	P	0,31	BCX18	A67
	N		BCX20	A67
	P	0,35	BCY72	A44
	N	0,5	BF199	A50
	P	0,8	BC328	A43
	N		BC338	A43
	N	1	BSW41A	A54
	N		BFQ17	A68
	N		BFQ18	A68
	N	1,5	BFR95	A65
	N		BFW16A	A65
	N		BFW17A	A65
	N	2,5	BFR94	A65
	N	3,5	BFR64	A65
	N	5	BFR65	A65
27	N	6,25	BLX96	A60
	N	12,5	BLX97	A60
	N	21,5	BLW98	A60
	N		BLX98	A60
30	N	0,145	BF115	A50
	F	0,15	BFW12	A56
	F		BFW13	A56
	P	0,16	BF967	A50
	M	0,2	BFR29	A56
	M		BSV81	A57
	N	0,25	BF196	A50
	P		BF324	A50
	F		BFQ10	A58
	F		BFQ11	A58
	F	0,25	BFQ12	A58
	F		BFQ13	A58
	F		BFQ14	A58
	F		BFQ15	A58
	F		BFQ16	A58
	F	0,3	BC264	A56
	F		BF245	A56
	F		BF256	A56
30 cont.	F	0,3	BFS21	A58
	F		BFS21A	A58
	F		BFW10	A56
	F		BFW11	A56
	F		2N3823	A56
	F		2N3966	A57
	F	0,36	2N4859	A57
	F		2N4860	A57
	F		2N4861	A57
	N	0,5	BC548	A43
	N		BC549	A43
	P		BC558	A43
	P		BC559	A43
	N		BF198	A50
	N		2N2221	A55
	N		2N2222	A55
	N	0,8	BFY51	A51
	N		BSX60	A54
	N		2N2218	A55
	N		2N2219	A55
	N	5	BLW32	A60
	N		2N3866	A63
	N	10	BLW33	A60
	N	17,5	BLW34	A60
	N	50	BLX94A	A63
	N	76	BLX95	A63
32	P	0,345	BCY78	A44
	P	0,6	BCY33A	A44
	P		BCY34A	A44
	N	1	BCY58	A44
	N	36	BD435	A45
	P		BD436	A45
	N	40	BLW64	A60
	N	60	BLW75	A60
33	N	4	BLX91A	A63
	N	6	BLX92A	A63
	N	12,5	BLX93A	A63
35	N	0,8	BFY50	A51
	N		BFY55	A51
	N		2N2297	A51
35 cont.	N	140	BLW76	A63
	N	160	BLW78	A63
	N	245	BLW77	A63
36	N	8	BFS23A	A63
	N	17,5	BLY91A	A63
	N	18	BLY91C	A63
	N	32	BLY92A	A63
	N		BLY92C	A63
	N	50	BLX39	A63
	N	62,5	BLX13	A63
	N	70	BLX13C	A63
	N		BLY93A	A63
	N		BLY93C	A63
	N	76	BLW83	A63
	N		BLW84	A63
	N	88	BLX14	A63
	N	105	BLW86	A63
	N	130	BLY94	A63
40	N	0,15	BCY87	A58
	N		BCY88	A58
	N		BCY89	A58
	N	0,25	BF240	A50
	N		BF241	A50
	P		BF450	A50
	P		BF451	A50
	P	0,35	BCY70	A44
	F		BSV78	A57
	F		BSV79	A57
	F		BSV80	A57
	F		2N4856	A57
	F		2N4857	A57
	F		2N4858	A57
	P	0,4	2N2906	A55
	P		2N2907	A55
	N	0,5	2N2221A	A55
	N		2N2222A	A55
	P	0,6	2N2904	A55
	P		2N2905	A55
	P	0,8	BSV15	A54
	N		2N2218A	A55

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V

P listed by power dissipation
V listed by voltage

N = n-p-n
P = p-n-p
F = FET
M = MOS-FET

V_{CEO} V_{DS} max V		P_{tot} max W	type no.	page
40 cont.	N	0,8	2N2219A	A55
	F	1,8	2N4091	A57
	F		2N4092	A57
	F		2N4093	A57
	F		2N4391	A57
	F		2N4392	A57
	F		2N4393	A57
	N	3,7	BC140	A42
	P		BC160	A42
	N		BSX45	A54
	N	7	2N3553	A63
	N	11,6	2N3375	A63
	N	23	2N3632	A63
45	P	0,2	BCW69	A67
	P		BCW70	A67
	N		BCW71	A67
	N		BCW72	A67
	N	0,3	BC107	A42
	N		BC147	A42
	P		BC157	A42
	P		BC177	A42
	N		BCY56	A44
	N		2N929	A47
	N		2N930	A47
	P	0,31	BCX17	A67
	N		BCX19	A67
	P	0,345	BCY79	A45
	P	0,35	BCY71	A44
	N	0,5	BC547	A43
	N		BC550	A43
	P		BC557	A43
	P		BC560	A43
	P	0,8	BC327	A43
	N		BC337	A43
	N		BSR50	A54
	N		BSS50	A54
	P		BSS60	A54
	N		BSX59	A54
	N		BSX61	A54
	N	1	BC635	A43
	P		BC636	A44
45 cont.	P	1	BCX51	A67
	N		BCX54	A67
	N		BCY59	A44
	N	8	BD135	A44
	P		BD136	A44
	N	12,5	BD226	A44
	P		BD227	A45
	N	15	BD131	A44
	P		BD132	A44
	N	25	BD233	A45
	P		BD234	A45
	N	36	BD437	A45
	P		BD438	A45
	N	40	BD675	A46
	P		BD676	A46
	N	60	BD201	A44
	P		BD202	A44
	N		BD291	A45
	P		BD292	A45
50	N	0,8	2N1613	A51
	N		2N1711	A51
53	N	195	BLX15	A63
60	N	0,36	2N2483	A47
	N		2N2484	A47
	P	0,4	2N2906A	A55
	P		2N2907A	A55
	P	0,6	2N2904A	A55
	P		2N2905A	A55
	N	0,8	BSR51	A54
	N		BSS51	A54
	P		BSS61	A54
	P		BSV16	A54
	P		2N4030	A51
	P		2N4032	A51
	N	0,87	BFX34	A54
	N	1	BC637	A43
	P		BC638	A44
	P		BCX52	A67
	N		BCX55	A67
60 cont.	N	3,7	BC141	A42
	P		BC161	A42
	N	5	BSV64	A54
	N		BSX46	A54
	N	8	BD137	A44
	P		BD138	A44
	N	12,5	BD228	A44
	P		BD229	A45
	N	15	BD133	A44
	N	25	BD235	A45
	P		BD236	A45
	N	40	BD677	A46
	P		BD678	A46
	N		BDY92	A47
	N	60	BD203	A44
	P		BD204	A44
	N		BD293	A45
	P		BD294	A45
	N		BD331	A45
	P		BD332	A45
	N	62,5	BD645	A45
	P		BD646	A45
	P	90	BDX62	A46
	N		BDX63	A46
	N		BDX91	A47
	P		BDX92	A47
	P	117	BDX64	A46
	N		BDX65	A46
	P	125	BDV64	A46
	N		BDV65	A46
	P	150	BDX66	A46
	N		BDX67	A46
64	P	0,6	BCY30A	A44
	P		BCY31A	A44
	P		BCY32A	A44
65	N	0,5	BC546	A43
	P		BC556	A43
	P	5	2N4036	A55

V_{CEO} V_{DS} max V		P_{tot} max W	type no.	page
80	N	0,2	BSS64	A69
	N	0,3	BSX21	A54
	N	0,8	BSS52	A54
	P		BSV17	A54
	N		2N1893	A51
	N		2N3019	A55
	N		2N3020	A55
	P		2N4031	A51
	P		2N4033	A51
	N	1	BC639	A43
	P		BC640	A44
	P		BCX53	A67
	N		BCX56	A67
	N	5	BSX47	A54
	N	8	BD139	A44
	P		BD140	A44
	N	12,5	BD230	A44
	P		BD231	A45
	N	25	BD237	A45
	P		BD238	A45
	N	40	BD679	A46
	P		BD680	A46
	N		BDY91	A47
	N	60	BD333	A45
	P		BD334	A45
	N		BDX77	A46
	P		BDX78	A46
	N	62,5	BD647	A45
	P		BD648	A45
	P	90	BDX62A	A46
	N		BDX63A	A46
	N		BDX93	A47
	P		BDX94	A47
	P	117	BDX64A	A46
	N		BDX65A	A46
	P	125	BDV64A	A46
	N		BDV65A	A46
	P	150	BDX66A	A46
	N		BDX67A	A46
100	P	0,2	BSS63	A69
	N	0,5	BSS38	A54
	P		BSS68	A54
	N	0,8	BSW66	A54
	N	40	BD681	A46
	P		BD682	A46
	N		BDY90	A47
	N	60	BD335	A45
	P		BD336	A45
	N	62,5	BD649	A45
	P		BD650	A45
	P	90	BDX62B	A46
	N		BDX63B	A46
	N		BDX95	A47
	P		BDX96	A47
	P	117	BDX64B	A46
	N		BDX65B	A46
	P	125	BDV64B	A46
	N		BDV65B	A46
	P	150	BDX66B	A46
	N		BDX67B	A46
120	N	0,8	BSW67	A54
	N	62,5	BUY86	A54
	P	117	BDX64C	A46
	N		BDX65C	A46
130	N	0,8	BFW45	A51
150	N	0,8	BSW68	A54
	N	62,5	BUY87	A54
	N		BUY88	A54
160	N	6	BF457	A50
180	N	3	BF336	A50
	N	6	BD115	A44
200	P	1	2N5415	A55
	N	3	BF337	A50
225	N	3	BF338	A50
250	N	0,83	BF422	A50
	P		BF423	A50
	N	1	BF622	A69
	P		BF623	A69
	N	1,8	BF469	A50
	P		BF470	A50
	P	5	BFT45	A51
	N	6	BF458	A50
	N	30	BU133	A47
300	P	1	2N5416	A55
	P	5	BFT44	A51
	N	6	BF459	A50
	N	15	BD232	A45
	N		BU126	A47
375	N	70	BU426	A47
400	N	20	BUX86	A47
	N	40	BUX84	A47
	N	60	BU326A	A47
	N		BUX82	A47
	N	100	BUX80	A47
450	N	20	BUX87	A47
	N	40	BUX85	A47
	N	60	BUX83	A47
	N	100	BUX81	A47
600	N	10	BU204	A47
	N	12,5	BU207A	A47
700	N	10	BU205	A47
	N	12,5	BU208A	A47
800	N	10	BU206	A47
	N	12,5	BU209A	A47

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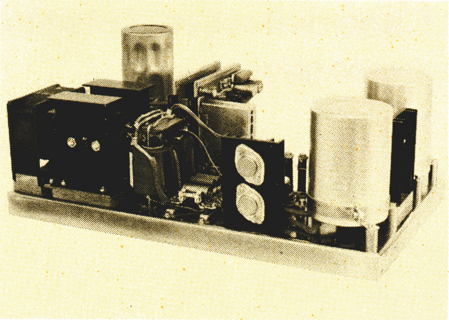
Polarity indication P = p-n-p
N = n-p-n

General purpose low frequency

P_{tot} max W	polarity	V_{CEO} max V	type	page
0,3	N	20	BC108	A42
	N	20	BC109*	A42
	N	20	BC148	A42
	N	20	BC149	A42
	P	20	BC159	A42
	P	20	BC179*	A42
	N	20	BCY57**	A44
	P	25	BC158	A42
	P	25	BC178	A42
	N	45	BC107	A42
	N	45	BC147	A42
	P	45	BC157	A42
	P	45	BC177	A42
	N	45	BCY56**	A44
	N	45	2N929	A47
	N	45	2N930	A47
0,34	N	12	AC127	A42
0,345	P	32	BCY78	A44
	P	45	BCY79	A44
0,35	P	25	BCY72	A44
	P	40	BCY70	A44
	P	45	BCY71	A44
0,36	N	60	2N2483	A47
	N	60	2N2484	A47
0,5	P	12	AC125	A42
	P	12	AC126	A42
	P	12	AC132	A42
	N	30	BC548	A43
	N	30	BC549*	A43
	P	30	BC558	A43
	P	30	BC559*	A43
	N	45	BC547	A43
	N	45	BC550*	A43
	P	45	BC557	A43
	P	45	BC560	A43
	N	65	BC546	A43
	P	65	BC556	A43
0,6	P	32	BCY33A	A44
	P	32	BCY34A	A44
	P	64	BCY30A	A44
	P	64	BCY31A	A44
	P	64	BCY32A	A44
0,8	P	45	BC327	A43
	N	45	BC337	A43
	P	25	BC328	A43
	N	25	BC338	A43
1	P	16	AC128	A42
	P	16	AC128/01	A42
	N	32	BCY58	A44
	N	45	BC635	A43
	P	45	BC636	A44
	N	45	BCY59	A44
	N	60	BC637	A43
	P	60	BC638	A44
	N	80	BC639	A43
	P	80	BC640	A44
3,7	N	40	BC140	A42
	P	40	BC160	A42
	N	60	BC141	A42
	P	60	BC161	A42
7	N	300	BD232	A45
15	N	45	BD131	A44
	P	45	BD132	A44
	N	60	BD133	A44
40	N	60	BDY92	A47
	N	80	BDY91	A47
	N	100	BDY90	A44
117	N	120	2N4347	A47
	N	140	2N3442	A47

* Very low noise preamplifier.   ** High gain, low noise.



1000 W, 18 V, mains-fed switched-mode power supply containing forward converter with 2 x BUX80 in parallel; efficiency at full load is 80%.

Other general purpose transistors

see h.f. and switching transistors

P_{tot} max W	polarity	V_{CEO} max V	I_C A	type	page
0,4	N	40	0,6	2N2906	A55
	N	60		2N2906A	A55
	N	40		2N2907	A55
	N	60		2N2907A	A55
0,5	P	30	0,8	2N2221	A55
	P	40		2N2221A	A55
	P	30		2N2222	A55
	P	40		2N2222A	A55
	N	80	0,1	BSS38	A54
	P	100		BSS68	A54
0,6	N	40	0,6	2N2904	A55
	N	60		2N2904A	A55
	N	40		2N2905	A55
	N	60		2N2905A	A55

P_{tot} max W	polarity	V_{CEO} max V	I_C A	type	page
0,8	N	30	0,8	2N2218	A55
	N	40		2N2218A	A55
	N	30		2N2219	A55
	N	40		2N2219A	A55
	P	60		2N4030	A55
	P	80		2N4031	A55
	P	60		2N4032	A55
	P	80		2N4033	A55
	N	80		2N3019	A55
	N	80		2N3020	A55
4	N	35	1	BFY55	A51
5	N	20	1	BFY52	A51
	N	30		BFY51	A51
	N	35		BFY50	A51
	P	35		BFS95	A51
	P	40		BFS94	A51
	P	60		BFS92	A51
	P	60		BFS93	A51
	P	65		2N4036	A55

Switched-mode power supplies
polarity n-p-n

type	V_{CEO} max V	P_{tot} max W	t_{on} max µs	t_f max µs	page
BU426	375	70	0,5	1	A47
BUX80	400	100	0,5	0,8	A47
BUX81	450	100	0,5	0,8	A47
BUX82	400	60	0,5	1	A47
BUX83	450	60	0,5	1	A47
BUX84	400	40	0,5	1,4	A47
BUX85	450	40	0,5	1,4	A47
BUX86	400	20	0,5	1,3	A47
BUX87	450	20	0,5	1,3	A47

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Transistor pairs for class B — complementary

P_{tot} max per transistor W	V_{CEO} max V	type n-p-n/p-n-p	page
0,8	25	BC338/BC328	A43
1	15	AC187/AC188	A42
		AC187/01/AC188/01	A42
	20	BC368/BC369	A43
4/6	45	BD135/BD136	A44
8	60	BD137/BD138	A44
	80	BD139/BD140	A44
12,5	45	BD226/BD227	A44, A45
	60	BD228/BD229	A44, A45
	80	BD230/BD231	A44, A45
15	20	BD329/BD330	A45
25	45	BD233/BD234	A45
	60	BD235/BD236	A45
	80	BD237/BD238	A45
36	22	BD433/BD434	A45
	32	BD435/BD436	A45
	45	BD437/BD438	A45
60	45	BD201/BD202	A44
	45	BD291/BD292	A45
	60	BD203/BD204	A44
	60	BD293/BD294	A45
	80	BDX77/BDX78	A46
90	60	BDX91/BDX92	A47
	80	BDX93/BDX94	A47
	100	BDX95/BDX96	A47

Hearing aids

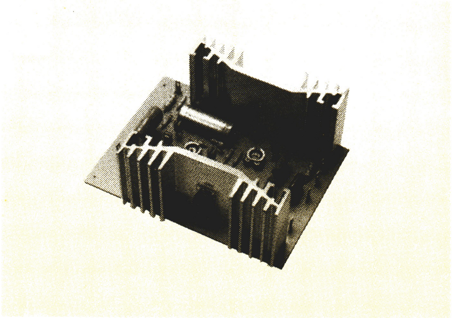
P_{tot} max mW	polarity	V_{CEO} max V	type	page
50	N	20	BC146	A42
50	P	20	BC200	A43

Transistor pairs for class B — complementary
DARLINGTONS

P_{tot} max per transistor W	V_{CEO} max V	type n-p-n/p-n-p	page
40	45	BD675/BD676	A46
	60	BD677/BD678	A46
	80	BD679/BD680	A46
	100	BD681/BD682	A46
60	60	BD331/BD332	A45
	80	BD333/BD334	A45
	100	BD335/BD336	A45
62,5	60	BD645/BD646	A45
	80	BD647/BD648	A45
	100	BD649/BD650	A45
90	60	BDX63/BDX62	A46
	80	BDX63A/BDX62A	A46
	100	BDX63B/BDX62B	A46
117	60	BDX65/BDX64	A46
	80	BDX65A/BDX64A	A46
	100	BDX65B/BDX64B	A46
	120	BDX65C/BDX64C	A46
125	60	BDV65/BDV64	A46
	80	BDV65A/BDV64A	A46
	100	BDV65B/BDV64B	A46
150	60	BDX67/BDX66	A46
	80	BDX67A/BDX66A	A46
	100	BDX67B/BDX66B	A46

Transistor pairs for class B — quasi-complementary

P_{tot} max per transistor W	polarity	V_{CEO} max V	type	page
1	N	16	2—AC128	A42
1	P	15	2—AC188	A42
115	N	60	2—BDY20	A46



25 W, 4 Ω hi-fi audio amplifier using Darlington transistors.

Television

For driver stages, correction circuits, sound output, vertical output, video output and power supplies

P_{tot} max per transistor W	V_{CEO} max V	I_{CM} max A	type p-n-p	n-p-n	page
1	45	1	BC636	BC635	A43, A44
	60	1	BC638	BC637	A43, A44
	80	1	BC640	BC639	A43, A44
6	180	0,2	–	BD115	A44
7	300	0,5	–	BD232	A45
8	45	1,5	BD136	BD135	A44
	60	1,5	BD138	BD137	A44
	100	1,5	BD140	BD139	A44
12,5	45	3	BD227	BD226	A44, A45
	60	3	BD229	BD228	A44, A45
	80	3	BD231	BD230	A44, A45
25	45	6	BD234	BD233	A45
	60	6	BD236	BD235	A45
	80	6	BD238	BD237	A45
90	60	12	BDX92	BDX91	A46
	80	12	BDX94	BDX93	A46
	100	12	BDX96	BDX95	A46

DARLINGTONS

P_{tot} max per transistor W	V_{CEO} max V	I_{CM} max A	type p-n-p	n-p-n	page
62,5	60	12	BD646	BD645	A45
	80	12	BD648	BD647	A45
	100	12	BD650	BD649	A45
90	60	12	BDX62	BDX63	A46
	80	12	BDX62A	BDX63A	A46
	100	12	BDX62B	BDX63B	A46
117	60	16	BDX64	BDX65	A46
	80	16	BDX64A	BDX65A	A46
	100	16	BDX64B	BDX65B	A46

For line output

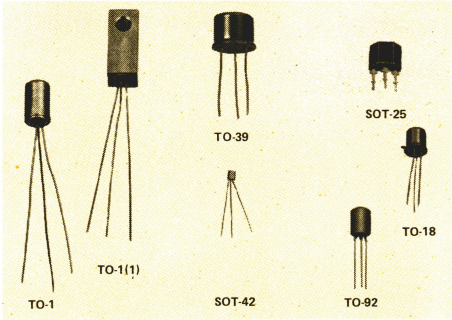
P_{tot} max W	V_{CERM} max V	I_{CM} max A	type n-p-n	page
10	1300	3	BU204	A47
	1500	3	BU205	A47
	1700	3	BU206	A47
12,5	1500	7,5	BU207A	A47
	1500	7,5	BU208A	A47
	1700	6	BU209A	A47
30	750	6	BU126	A47
	750	6	BU133	A47
60	800	6	BU426	A47
60	900	8	BU326A	A47

I.f. and deflection transistors

abridged data

Polarity indication P = p-n-p
N = n-p-n

type	polarity	status	case	RATINGS V_{CBO} V	V_{CEO} V	I_C A	P_{tot} W	at T_{amb} (T_{case}) °C	CHARACTERISTICS h_{FE} min–max	at I_C mA	F typ dB	f_T typ MHz	V_{CEsat} typ mV	at I_C/I_B A/mA
AC125	P	C	TO-1	32	12	0,1	0,5	45	50	2	4	1,7	–	–
AC126	P	C	TO-1	32	12	0,1	0,5	45	65	2	4	2,3	–	–
AC127	N	C	TO-1	32	12	0,5	0,34	45	typ 90	200	4	2,5	–	–
AC128	P	C	TO-1	32	16	1	1	20	60–175	300	–	1,5	–	–
AC128/01	P	C	TO-1 (1)	32	16	1	1	20	60–175	300	–	1,5	–	–
AC132	P	C	TO-1	32	12	0,2	0,5	45	typ 115	50	4	2	–	–
AC187	N	C	TO-1	25	15	1	1	35	100–500	300	–	5	–	–
AC187/01	N		TO-1 (1)									5		
AC188	P		TO-1									1,5		
AC188/01	P		TO-1 (1)									1,5		
BC107	N	D	TO-18 (1)	50	45	0,1	0,3	25	110–450	2	2	300	200	0,1/5
BC108				30	20				110–800		2			
BC109				30	20				200–800		1,2			
BC107A, B				50	45				A 110–220		2			
BC108A, B, C				30	20				B 200–450		2			
BC109B, C				30	20				C 420–800		1,2			
BC140-6, 10, 16	N	D	TO-39 (1)	80	40	1	3,7	(45)	6 40–100	100	–	> 50	600	1/100
BC141-6, 10, 16	N	D	TO-39 (1)	100	60				10 63–160					
									16 100–250					
BC146/01	N	D	SOT-42	20	20	0,05	0,05	45	80–200	0,2	2	150	–	–
BC146/02									140–350		1,5			
BC146/03									280–550		2			
BC147	N	C	SOT-25(1)	50	45	0,1	0,3	25	110–450	2	2	300	200	0,1/5
BC148				30	20				110–800		2			
BC149				30	20				200–800		1,2			
BC147A, B				50	45				A 110–220		2			
BC148A, B, C				30	20				B 200–450		2			
BC149B, C				30	20				C 420–800		1,2			
BC157	P	C	SOT-25(1)	50	45	0,1	0,3	25	75–260	2	2	150	250	0,1/5
BC158				30	25				75–500		2			
BC159				25	20				125–500		1			
BC158A, B				30	25				A 125–260		2			
BC159A, B				25	20				B 240–500		1			
BC160-6, 10, 16	P	D	TO-39 (1)	40	40	1	3,7	(45)	6 40–100	100	–	> 50	600	1/10
BC161-6, 10, 16	P	D	TO-39 (1)	60	60				10 63–160					
									16 100–250					
BC177	P	D	TO-18 (1)	50	45	0,1	0,3	25	75–260	2	2	150	250	0,1/5
BC178				30	25				75–500		2			
BC179				25	20				125–500		1			
BC178A, B				30	25				A 125–260		2			
BC179A, B				25	20				B 240–500		1			



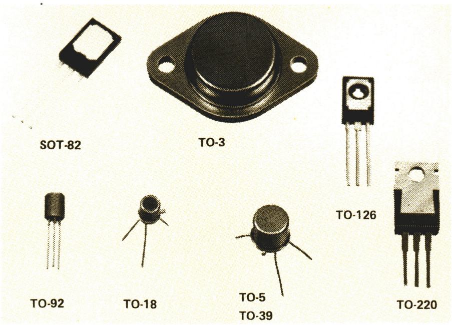
type	polarity	status	case	RATINGS V_{CBO} (V_{CES}) V	V_{CEO} V	I_C A	P_{tot} W	at T_{amb} °C		CHARACTERISTICS h_{FE} min–max	at I_C mA	F typ dB	f_T typ MHz	V_{CEsat} max mV	at I_C/I_B A/mA
BC200/01	P	D	SOT-42	20	20	0,05	0,05	45		50–105	0,2	2	90	–	–
BC200/02										85–200		1,5			
BC200/03										165–400		2			
BC327	P	D	TO-92(2)	(50)	45	0,5	0,8	25		100–600	100	–	100	700	0,5/50
BC328				(30)	25					100–600					
BC327-16, 25, 40				(50)	45				**16**	100–250					
BC328-16, 25, 40				(30)	25				**25**	160–400					
									40	250–640					
BC337	N	D	TO-92(2)	(50)	45	0,5	0,8	25		100–600	100	–	200	700	0,5/50
BC338				(30)	25					100–600					
BC337-16, 25, 40				(50)	45				**16**	100–250					
BC338-16, 25, 40				(30)	25				**25**	160–400					
									40	250–640					
BC368	N	D	TO-92(3)	(25)	20	1	1	25		85–375	500	–	60	500	1/100
BC369	P														
BC546	N	D	TO-92(2)	80	65	0,1	0,5	25		110–450	2	2	300	600	0,1/5
BC547				50	45					110–800					
BC548				30	30					110–800					
BC546A, B				80	65				**A**	110–220					
BC547A, B, C				50	45				**B**	200–450					
BC548A, B, C				30	30				**C**	420–800					
BC549	N	D	TO-92(2)	30	30	0,1	0,5	25		200–800	2	1,4	300	600	0,1/5
BC550				50	45					200–800					
BC549B, C				30	30				**B**	200–450					
BC550B, C				50	45				**C**	420–800					
BC556	P	D	TO-92(2)	80	65	0,1	0,5	25		75–250	2	2	150	650	0,1/5
BC557				50	45					75–475					
BC558				30	30					75–475					
BC556A				80	65										
BC557A, B				50	45				**A**	125–250					
BC558A, B				30	30				**B**	220–475					
BC559	P	D	TO-92(2)	30	30	0,1	0,5	25		125–475	2	1	150	650	0,1/5
BC560				50	45					125–475					
BC559A, B				30	30				**A**	125–250					
BC560A, B				50	45				**B**	220–475					
BC635	N	D	TO-92(3)	45	45	1	1	25		40–250	150	–	130	500	0,5/50
BC637				60	60					40–160					
BC639				100	80					40–160					

I.f. and deflection transistors

abridged data

Polarity indication P = p-n-p
N = n-p-n

type	polarity	status	case	RATINGS V_{CBO} (V_{CES}) V	 V_{CEO} V	 I_C A	 P_{tot} W	 at T_{amb} (T_{mb}) °C	CHARACTERISTICS h_{FE} min–max	 at I_C mA	 F typ dB	 f_T typ MHz	 V_{CEsat} max V	 at I_C/I_B A/mA
BC636	P	D	TO-92 (3)	45	45	1	1	25	40–250	150	–	50	0,5	0,5/50
BC638				60	60				40–160					
BC640				100	80				40–160					
BCY30A	P	D	TO-5(1)	64	64	0,05	0,6	25	10– 35	20	8	7	0,55	0,02/3
BCY31A				64	64				15– 60					
BCY32A				64	64				20– 70					
BCY33A				32	32				10– 35					
BCY34A				32	32				15– 60					
BCY56	N	D	TO-18 (1)	45	45	0,1	0,3	25	100–450	2	1,5	85	typ 0,2	0,1/10
BCY57				25	20				200–800			100		
BCY58 VII	N	D	TO-18 (1)	(32)	32	0,2	1	45 (T_{case})	VII 120–220	2	2	280	0,7	0,1/2,5
VIII, IX, X									VIII 180–310					
BCY59 VII,				(45)	45				IX 250–460					
VIII, IX, X									X 380–630					
BCY70	P	D	TO-18 (1)	50	40	0,2	0,35	25	100	10	< 6	> 250	0,5	0,05/5
BCY71				45	45				100–400		< 2			
BCY72				30	25				100		< 6			
BCY78 VII	P	D	TO-18(1)		32	0,2	0,345	(45)	VII 125–250	2	–	180	0,8	0,1/2,5
VIII, IX, X									VIII 175–350					
BCY79 VII					45				IX 250–500					
VIII, IX									X 350–700					
BD115	N	C	TO-39 (1)	245	180	0,15	6	50	22– 60	50	–	145	9	0,1/10
BD131	N	C	TO-126	70	45	3	15	(60)	40	500	–	> 60	0,7	2/200
BD132	P			45	45									
BD133	N			90	60									
BD135	N	D	TO-126	45	45	1	8	(70)	40–250	150	–	250	0,5	0,5/50
BD137				60	60									
BD139				100	80									
BD136	P	D	TO-126	45	45	1	8	(70)	40–250	150	–	75	0,5	0,5/50
BD138				60	60									
BD140				100	80									
BD201	N	D	TO-220 (1)	60	45	8	60	25	30	3	–	> 3	1	3/300
BD203					60					2				
BD202	P	D	TO-220 (1)	60	45	8	60	25	30	3	–	> 3	1	3/300
BD204					60					2				
BD226	N	D	TO-126	45	45	1,5	12,5	62	40–250	0,15	–	125	0,8	1/100
BD228				60	60				40–160					
BD230				100	80				40–160					



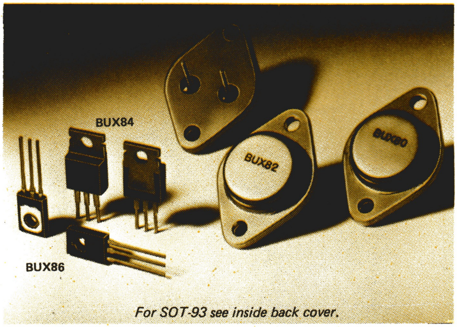
				RATINGS					CHARACTERISTICS					
type	polarity	status	case	V_{CBO} (V_{CERM}) V	V_{CEO} V	I_C A	P_{tot} W	at T_{mb} (T_{amb}) °C	h_{FE} min–max	at I_C A	f_{hfe} typ kHz	f_T typ MHz	V_{CEsat} max V	at I_C/I_B A/mA
BD227	P	D	TO-126	45	45	1,5	12,5	62	40–250	0,15	–	50	0,8	1/100
BD229				60	60				40–160					
BD231				100	80				40–160					
BD232	N	D	TO-126	(500)	300	0,25	15	57	25–150	0,05	–	20	1	0,15/15
BD233	N	D	TO-126	45	45	2	25	25	40–250	0,15	–	> 3	0,6	1/100
BD235				60	60									
BD237				100	80									
BD234	P	D	TO-126	45	45	2	25	25	40–250	0,15	–	> 3	0,6	1/100
BD236				60	60									
BD238				100	80									
BD291	N	D	SOT-82	45	45	6	60	25	30	1	–	> 3	1	3/300
BD293				60	60									
BD292	P	D	SOT-82	45	45	6	60	25	30	1	–	> 3	1	3/300
BD294				60	60									
BD329	N	D	TO-126	32	20	3	15	45	40	2	–	130	0,5	2/200
BD330	P										–	100		
BD331	N	D	SOT-82	60	60	6	60	25	750	3	60	7	2	3/12
BD333				80	80									
BD335				100	100									
BD332	P	D	SOT-82	60	60	6	60	25	750	3	60	7	2	3/12
BD334				80	80									
BD336				100	100									
BD433	N	D	TO-126	22	22	4	36	25	85–475	0,5	–	> 3	0,5	2/200
BD435				32	32				85–475				0,5	2/200
BD437				45	45				85–375				0,7	3/300
BD434	P	D	TO-126	22	22	4	36	25	85–475	0,5	–	> 3	0,5	2/200
BD436				32	32				85–475				0,5	2/200
BD438				45	45				85–375				0,7	3/300
BD645	N	D	TO-220 (1)	80	60	8	62,5	25	750	3	100	–	2	3/12
BD647				100	80									
BD649				120	100									
BD646	P	D	TO-220 (1)	60	60	8	62,5	25	750	3	100	–	2	3/12
BD648				80	80									
BD650				100	100									

l.f. and deflection transistors

abridged data

Polarity indication P = p-n-p
N = n-p-n

				RATINGS					CHARACTERISTICS					
type	polarity	status	case	V_{CBO} V	V_{CEO} V	I_C A	P_{tot} W	at T_{mb} °C	h_{FE} at min–max	I_C A	f_{hfe} typ kHz	f_T typ MHz	V_{CEsat} max V	at I_C/I_B A/mA
BD675 **BD677** **BD679** **BD681**	N	D	TO-126	45 60 80 100	45 60 80 100	4	40	25	750	1,5	–	7	2,5	1,5/6
BD676 **BD678** **BD680** **BD682**	P	D	TO-126	45 60 80 100	45 60 80 100	4	40	25	750	1,5	–	7	2,5	1,5/6
BDV64 **BDV64A** **BDV64B**	P	D	SOT-93	60 80 100	60 80 100	10	125	25	1000	5	100	–	2	5/20
BDV65 **BDV65A** **BDV65B**	N	D	SOT-93	60 80 100	60 80 100	10	125	25	1000	5	70	–	2	5/20
BDX62 **BDX62A** **BDX62B**	P	C	TO-3 (2)	60 80 100	60 80 100	8	90	25	1000	3	100	–	2	3/12
BDX63 **BDX63A** **BDX63B**	N	C	TO-3 (2)	80 100 120	60 80 100	8	90	25	1000	3	100	–	2	3/12
BDX64 **BDX64A** **BDX64B** **BDX64C**	P	C	TO-3 (2)	60 80 100 120	60 80 100 120	12	117	25	1000	5	80	–	2	5/20
BDX65 **BDX65A** **BDX65B** **BDX65C**	N	C	TO-3 (2)	80 100 120 140	60 80 100 120	12	117	25	1000	5	50	–	2	5/20
BDX66 **BDX66A** **BDX66B**	P	C	TO-3 (2)	60 80 100	60 80 100	16	150	25	1000	10	60	–	2	10/40
BDX67 **BDX67A** **BDX67B**	N	C	TO-3 (2)	80 100 120	60 80 100	16	150	25	1000	10	50	–	2	10/40
BDX77 **BDX78**	N P	C	TO-220 (1)	100	80	8	60	25	30	2	> 25	> 3	1	3/300



For SOT-93 see inside back cover.

				RATINGS					CHARACTERISTICS					
type	polarity	status	case	(V_{CBO}) V_{CESM} V	V_{CEO} V	I_C (I_{CM}) A	P_{tot} W	at T_{mb} (T_{amb}) °C	h_{FE} min–max	at I_C A	t_f max T_{mb} = 95 °C µs	f_T typ MHz	V_{CEsat} max V	at I_C/I_B A/mA
BDX91	N	C	TO-3 (2)	60	60	8	90	25	20	3	–	> 4	0,8	3/300
BDX93				80	80									
BDX95				100	100									
BDX92	P	C	TO-3 (2)	60	60	8	90	25	20	3	–	> 4	0,8	3/300
BDX94				80	80									
BDX96				100	100									
BDY90	N	D	TO-3(1)	(120)	100	10	40	75	30–120	5	–	70	1,5	10/1000
BDY91				(100)	80								1,5	
BDY92				(80)	60								1	
BU126	N	D	TO-3(1)	750	300	3	30	50	15– 60	1	–	8	10	2,5/250
BU133	N	D	TO-3(1)	750	250	3	30	50	15– 80	1	–	8	10	2,5/250
BU204	N	D	TO-3(1)	1300	600	2,5	10	90	2	2	–	7,5	5	2/1000
BU205				1500	700				2					2/1000
BU206				1700	800				1,8					2/1100
BU207A	N	D	TO-3(1)	1500	600	5	12,5	95	2,25	4,5	–	7	5	4,5/2000
BU208A				1500	700	5			2,5	4,5			1	4,5/2000
BU209A				1700	800	4			2,25	3			5	3/1300
BU326A	N	D	TO-3(1)	900	400	6	60	50	typ 30	0,6	1	6	3	4/1250
BU426	N	N	SOT-93	800	375	6	70	< 73	typ 30	0,6	1	6	1,5	2,5/500
BUX80	N	D	TO-3(1)	800	400	10	100	40	typ 30	1,2	0,8	6	1,5	5/1000
BUX81				1000	450	10	100	40		1,2	0,8			5/1000
BUX82				800	400	6	60	50		0,6	1			2,5/500
BUX83				1000	450	6	60	50		0,6	1			2,5/500
BUX84	N	D	TO-220(1)	800	400	2	40	50	typ 50	0,1	1,4	20	1,5	0,3/30
BUX85			TO-220(1)	1000	450	2	40	50		0,1	1,4			0,3/30
BUX86			TO-126	800	400	0,5	20	60		0,05	1,3			0,1/10
BUX87			TO-126	1000	450	0,5	20	60		0,05	1,3			0,1/10
2N929	N	D	TO-18(1)	(45)	45	0,03	0,3	25	100–350	0,01	–	80	1	0,01/0,5
2N930									150–600					
2N2483	N	D	TO-18(1)	(60)	60	(0,05)	0,36	(25)	40–120	0,01	–	60	0,35	0,001/01
2N2484									100–500			80		

h.f. transistors

selection guide

radio
television
industrial

Polarity indication P = p-n-p
N = n-p-n
M = MOS

Radio

type	polarity	r.f. amplifier		mixer or self-oscillating mixer		i.f. amplifier
		a.m.	f.m.	a.m.	f.m.	
BF240	N	●		●	●	●
BF241	N	●		●	●	●
BF324	P		●			
BF450	P	●		●	●	●
BF451	P	●		●	●	●
BF494	N		●	●	●	●
BF495	N	●	●	●	●	●
BF936	P				●	

h.f. packages for radio

40835 contains	BF494B	for use as mixer or self-oscillating mixer
	BF495C	for first i.f. stage
	BF495D	for final i.f. stage
40838 contains	BF240B	for use as mixer or self-oscillating mixer
	BF241C	for first i.f. stage
	BF241D	for final i.f. stage

Television

type	polarity	Tuners						Vision amplifiers	
		preamplifier		mixer or self-oscillating mixer		oscillator			video output
		u.h.f.	v.h.f.	u.h.f.	v.h.f.	u.h.f.	v.h.f.	i.f.	
BF198	N							●	
BF199	N							●	
BF200	N		●						
BF324	P				●		●		
BF336	N								●
BF337	N								●
BF338	N								●
BF362	N	●							
BF363	N			●		●			
BF422	N								●
BF423	P								●
BF457	N								●
BF458	N								●
BF459	N								●
BF469	N								●
BF470	P								●
BF480	N	●	●			●			
BF494	N						●		
BF495	N						●		
BF936	P				●		●		
BF327	M (see page A56)		●		●				
BF939	P		●		●				
BF967	P	●		●					
BF979	P	●	●	●					

Industrial

		type	polarity	f_T min MHz
general purpose; selected by f_T	*	BSS68	P	50
		BSS38	N	60
	*	2N3020	N	80
		2N3019	N	100
		2N4030	P	100
		2N4031	P	100
		2N4032	P	150
		2N4033	P	150
		BFY50	N	typ 140
		BFY51	N	typ 160
		BFY52	N	typ 185
	*	2N2904	P	200
		2N2904A	P	200
		2N2905	P	200
		2N2905A	P	200
		2N2906	P	200
		2N2906A	P	200
		2N2907	P	200
		2N2907A	P	200
		2N2218	N	250
		2N2218A	N	250
		2N2219	N	250
		2N2221	N	250
		2N2221A	N	250
		2N2222	N	250
		2N2219A	N	300
		2N2222A	N	300
line output transistor for wideband oscilloscopes		BFW45	N	80
h.f. and v.h.f. oscillators and amplifiers, output stages of servo amplifiers		BFY55	N	60
		2N2297	N	60
		2N918	N	900
d.c. to h.f. amplifiers; also for switching		2N1893	N	50
		2N1613	N	60
		2N1711	N	70
u.h.f. low-power amplifier, e.g. for pocket phones		BFT24	N	1200
high-voltage transistors		BFT44	P	typ 60
		BFT45	P	typ 60

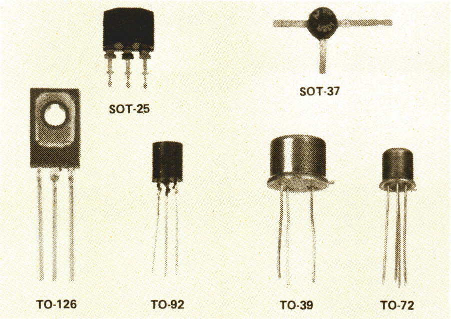
* for abridged data see switching transistors

h.f. transistors

abridged data

Polarity indication P = p-n-p
N = n-p-n

type	polarity	status	case	RATINGS V_{CEO}	I_C	P_{tot}	CHARACTERISTICS h_{FE}	at I_C	F typ	at f	f_T typ	C_{re} (C_{rb}) typ	at f
				V	mA	W	min – max	mA	dB	MHz	MHz	pF	MHz
AF367	P	C	SOT-37(1)	15	10	0,06	10	10	< 6	900	800	0,4	0,45
BF115	N	C	TO-72(2)	30	30	0,145	45 – 165	1	4	100	230	0,65	0,45
BF180	N	D	TO-72(1)	20	20	0,15	13	2	7	800	675	0,28	10,7
BF181	N	D	TO-72(1)	20	20	0,15	13	2	6,8	900	600	0,28	10,7
BF182	N	D	TO-72(1)	20	15	0,15	10	2	7,4	800	650	0,33	10,7
BF183	N	D	TO-72(1)	20	15	0,15	10	3	–	–	800	0,33	10,7
BF184	N	C	TO-72(2)	20	30	0,145	75 – 750	1	3	0,2	300	0,65	0,45
BF185	N	C	TO-72(2)	20	30	0,145	34 – 140	1	4	100	220	0,65	0,45
BF194	N	C	SOT-25(2)	20	30	0,25	typ 115	1	4	100	260	0,95	0,45
BF195	N	C	SOT-25(2)	20	30	0,25	typ 67	1	4	100	200	0,95	0,45
BF196	N	C	SOT-25(2)	30	25	0,25	27	4	3	35	400	0,2	10,7
BF197	N	C	SOT-25(2)	25	25	0,25	37	7	–	–	550	0,3	10,7
BF198	N	D	TO-92(1)	30	25	0,5	27	4	3	35	400	0,2	10,7
BF199	N	D	TO-92(1)	25	25	0,5	37	7	–	–	550	0,3	10,7
BF200	N	D	TO-72(1)	20	20	0,15	15	3	2,7	200	650	0,28	10,7
BF240	N	D	TO-92(1)	40	25	0,25	65 – 220	1	< 3,5	0,2	380	0,27	1
BF241	N	D	TO-92(1)	40	25	0,25	35 – 125	1	< 3,5	0,2	350	0,27	1
BF324	P	D	TO-92(2)	30	25	0,25	25	4	3	100	450	(0,1)	1
BF336	N	D	TO-39(1)	180	100	3	typ 60	30	–	–	130	3	0,5
BF337	N	D	TO-39(1)	200	100	3	typ 60	30	–	–	130	2	0,5
BF338	N	D	TO-39(1)	225	100	3	typ 60	30	–	–	130	3	0,5
BF362	N	D	SOT-37(4)	20	20	0,12	12	12	5	800	800	0,25	10,7
BF363	N	D	SOT-37(4)	20	20	0,12	12	12	5	800	> 620	0,25	10,7
BF422	N	D	TO-92(3)	250	20	0,83	50	25	–	–	> 60	< 1,6	0,5
BF423	P	D	TO-92(3)	250	20	0,83	50	25	–	–	> 60	< 1,6	0,5
BF450	P	D	TO-92(1)	40	25	0,25	62	1	2	0,1	325	0,35	1
BF451	P	D	TO-92(1)	40	25	0,25	30	1	2	0,1	325	0,35	1
BF457	N	D	TO-126	160	100	6	26	30	–	–	90	< 3,5	1
BF458				250									
BF459				300									
BF469	N	D	TO-126	250	30	1,8	50	25	–	–	> 60	< 1,8	0,5
BF470	P												
BF480	N	D	SOT-37(4)	15	20	0,14	10	10	3,5	800	1600	–	–
BF494	N	D	TO-92(1)	20	30	0,3	typ 115	1	4	100	260	0,85	0,45
BF495	N	D	TO-92(1)	20	30	0,3	typ 67	1	4	100	200	0,85	0,45
BF936	P	N	TO-92(2)	20	25	0,25	–	–	< 6	200	350	0,9	–
BF939	P	N	SOT-92(2)	25	20		–	–	3,5	200	675	–	–
BF967	P	N	SOT-37(1)	30	20	0,16	–	–	< 5	800	950	–	–
BF979	P	N	SOT-37(1)	20	20		–	–	5	800	1500	–	–



				RATINGS			CHARACTERISTICS						
type	polarity	status	case	V_{CEO} (V_{CER}) V	I_C (I_{CM}) mA	P_{tot} W	h_{FE} min – max	at I_C mA	F typ dB	at f MHz	f_T typ MHz	C_{re} typ pF	at f MHz
BFT24	N	D	SOT-37(2)	5	2,5	0,03	20	1	3,8	500	2300	< 0,4	1
BFT44	P	D	TO-39(1)	300	300	5	50–150	10	–	–	70		
BFT45	P	D	TO-39(1)	250	250	5	50–150	10	–	–	70		
BFW45	N	C	TO-39(1)	130	50	0,8	20–120	50	–	–	120	< 3,5	1
BFY50	N	D	TO-39(1)	35	1000	0,8	112	150	–	–	140		
BFY51	N	D	TO-39(1)	30	1000	0,8	123	150	–	–	160		
BFY52	N	D	TO-39(1)	20	1000	0,8	142	150	–	–	185		
BFY55	N	D	TO-39(1)	35	1000	0,8	40–120	150	–	–	> 60		
2N918	N	C	TO-72(1)	15	50	0,2	20	3	< 6	60	> 900		
2N1613	N	C	TO-39(1)	(50)	(1000)	0,8	40–120	150	< 12	0,001	> 60		
2N1711	N	C	TO-39(1)	(50)	(1000)	0,8	100–300	150	< 8	0,001	> 70		
2N1893	N	C	TO-39(1)	80	500	0,8	40–120	150	–	–	> 50		
2N2297	N	C	TO-39(1)	35	1000	0,8	40–120	150	–	–	> 60		
2N4030	P	D	TO-39(1)	60	1	0,8	25	500	–	–	> 100		
2N4031				80			25				> 100		
2N4032				60			70				> 150		
2N4033				80			70				> 150		

switching transistors

selection guide

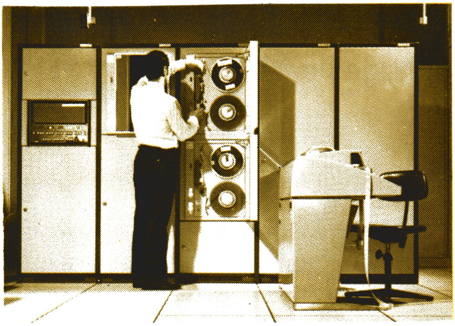
medium speed
high speed
trigger devices

Polarity indication P = p-n-p
N = n-p-n

Medium-speed transistors

	type	polarity	V_{CEO} (V_{CER}) V	P_{tot} W	t_{off} max ns
drivers for numerical indicator tubes	**BSS38**	N	100	0,5	1000
	BSS68	P	100	0,5	—
	BSX21	N	80	0,3	—
drivers, e.g. for print hammers	**BSR50**	N	(45)	0,8	2000
	BSR51	N	(60)	0,8	2000
	BSS50	N	(45)	0,8	2000
	BSS51	N	(60)	0,8	2000
	BSS52	N	(80)	0,8	2000
	BSS60	P	—	0,8	1500
	BSS61	P	—	0,8	1500
	BSV64	N	60	5	1200
general industrial and switching	**BSV15**	P	40	0,8	650
	BSV16	P	60	0,8	650
	BSV17	P	80	0,8	650
	BSX45	N	40	5	850
	BSX46	N	60	5	850
	BSX47	N	80	5	850
	2N4036	P	65	5	700

	type	polarity	V_{CEO} V	P_{tot} W	t_{off} max ns
switching inductive loads	**BSW66**	N	100	0,8	1000
	BSW67	N	120	0,8	1000
	BSW68	N	150	0,8	1000
saturated switching	**2N2894**	P	12	0,36	90
amplifiers and switching circuits	**2N3019**	N	80	0,8	—
	2N3020	N	80	0,8	—
	2N5415	P	200	1	—
	2N5416	P	300	1	—
inverting, regulating, etc.	**BFX34**	N	60	0,87	1200
	BUY86	N	120	62,5	1300
	BUY87	N	150	62,5	1300
	BUY88	N	150	62,5	1300
for abridged data see l.f. transistors	**BCY58**	N	32	0,33	800
	BCY59	N	45	0,33	800
	BDY90	N	100	40	1500
	BDY91	N	80	40	1500
	BDY92	N	60	40	1500



High-speed transistors

	type	polarity	V_{CEO} V	P_{tot} W	t_{off} max ns
core driving	**BSW41A**	N	25	1	60
	BSX59	N	45	0,8	60
	BSX60	N	30	0,8	70
	BSX61	N	45	0,8	100
saturated switching	**BSX19**	N	15	0,36	18
	BSX20	N	15	0,36	21
	2N2368	N	15	0,36	15
	2N2369	N	15	0,36	18
	2N2369A	N	15	0,36	18
	2N2894A	P	12	0,36	35

	type	polarity	V_{CEO} V	P_{tot} W	t_{off} max ns
saturated switching and driver applications for industrial service	**2N2904**	P	40	0,6	100
	2N2904A	P	60	0,6	100
	2N2905	P	40	0,6	100
	2N2905A	P	60	0,6	100
	2N2906	P	40	0,4	100
	2N2906A	P	60	0,4	100
	2N2907	P	40	0,4	100
	2N2907A	P	60	0,4	100
	2N2218	N	30	0,8	–
	2N2218A	N	40	0,8	285
	2N2219	N	30	0,8	–
	2N2219A	N	40	0,8	285
	2N2221	N	30	0,5	–
	2N2221A	N	40	0,5	285
	2N2222	N	30	0,5	–
	2N2222A	N	40	0,5	285

Trigger devices

BR101
BRY39
BRY56

PNPN devices for relay and lamp drivers, sensing networks for temperature control, oscillators, timers, pulse shapers, and as replacements for relays, silicon controlled switches, programmable unijunction transistors.
The BRY39 can also be used for driving numerical indicator tubes.

type	status	case	RATINGS V_{GA} V	 V_{GK} V	 I_{ARM} 10 μs; δ = 0,01 A	 dI_A/dt A/μs	 P_{tot} mW	CHARACTERISTICS V_{AK} max V	 I_H max mA	 t_r max ns
BR101	D	TO-72(3)	50	5	2,5	–	275	1,4	1	–
BRY39	D	TO-72(3)	70	5	2,5	20	275	1,4	1	80
BRY56	D	TO-92(4)	70	70	2,5	20	300	1,4	–	80

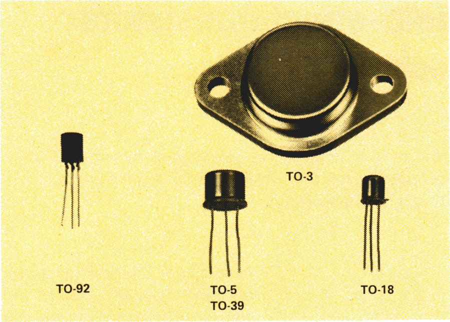
switching transistors

abridged data

For trigger devices see page 53

Polarity indication P = p-n-p
N = n-p-n

				RATINGS				CHARACTERISTICS					
type	polarity	status	case	V_{CEO} (V_{CER})	I_C (I_{CM})	P_{tot}	at T_{amb} (T_{case})	h_{FE}	at I_C	V_{CEsat} max	at I_C/I_B	t_{off} max	at I_C
				V	A	W	°C	min–max	mA	V	mA/mA	ns	A
BFX34	N	D	TO-39(1)	60	2	0,87	25	40–150	2000	1	5000/500	1200	5
BSR50 BSR51	N	N	TO-92(3)	45 60	(2)	0,8	25	2000	500	1,3	500/0,5	2000	1
BSS38	N	D	TO-92(2)	100	0,1	0,5	25	20	4	0,7	4/0,4	1000	0,015
BSS50 BSS51 BSS52	N	D	TO-39(1)	(45) (60) (80)	1	0,8	25	2000	500	1,6	1000/4 1000/1 1000/4	2000	1
BSS60 BSS61	P	D	TO-39(1)	(45) (60)	0,1	0,8	25	2000	500	1,6	1000/1 1000/4	1500	0,5
BSS68	P	D	TO-92(2)	100	0,1	0,5	25	30	25	0,25	25/2,5	–	–
BSV15-6, 10, 16 BSV16-6, 10, 16 BSV17-6, 10	P	D	TO-39(1)	40 60 80	1	0,8	25	**6** 40–100 **10** 63–160 **16** 100–250	100	1	500/25	650	0,1
BSV64	N	D	TO-39(1)	60	2	5	(50)	40	2000	1	5000/500	1200	5
BSW41A	N	D	TO-18(1)	25	0,3	1	(25)	15	500	0,7	500/35	60	0,5
BSW66 BSW67 BSW68	N	D	TO-39(1)	100 120 150	1	0,8	25	30	500	0,4 0,4 0,5	500/50	typ 1000	0,5
BSX19 BSX20	N	D	TO-18(1)	15	(0,5)	0,36	25	20– 60 40–120	10	0,6	100/10	18 21	0,1
BSX21	N	D	TO-18(1)	80	0,1	0,3	25	20	4	0,7	4/0,4	–	–
BSX45-6, 10, 16 BSX46-6, 10, 16 BSX47-6, 10, 16	N	D	TO-39(1)	40 60 80	1	5	(25)	**6** 40–100 **10** 63–160 **16** 100–250	100	1 1 0,9	1000/100 1000/100 500/25	850	–
BSX59 BSX60 BSX61	N	D	TO-39(1)	45 30 45	1	0,8	25	30– 90	500	0,5 0,5 0,7	500/50	60 70 100	0,5
BUY86 BUY87 BUY88	N	N	TO-3(2)	120 150 150	7	62,5	25	50 30 30	1000 2000 1000	1 1,3 1,3	7000/700	1300	7

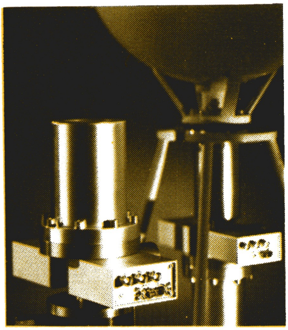


				RATINGS				CHARACTERISTICS					
type	polarity	status	case	V_{CEO}	I_C (I_{CM})	P_{tot}	at T_{amb} (T_{case})	h_{FE}	at I_C	V_{CEsat} max	at I_C/I_B	t_{off} max	at I_C
				V	A	W	°C	min–max	mA	V	mA/mA	ns	A
2N2218	N	D	TO-39(1)	30	0,8	0,8	25	40–120	150	0,4	150/15	–	–
2N2219			TO-39(1)			0,8		100–300					
2N2221			TO-18(1)			0,5		40–120					
2N2222			TO-18(1)			0,5		100–300					
2N2218A	N	D	TO-39(1)	40	0,8	0,8	25	40–120	150	0,3	150/15	285	0,15
2N2219A			TO-39(1)			0,8		100–300					
2N2221A			TO-18(1)			0,5		40–120					
2N2222A			TO-18(1)			0,5		100–300					
2N2368	N	C	TO-18(1)	15	(0,5)	0,36	25	20– 60	10	0,25	10/1	15	0,01
2N2369					(0,5)			40–120		0,25		18	
2N2369A					0,2			40–120		0,2		18	
2N2894	P	D	TO-18(1)	12	0,2	0,36	25	40–150	30	0,2	30/3	90	0,03
2N2894A								40–120		0,19		35	
2N2904	P	D	TO-39(1)	40	0,6	0,6	25	40–120	150	0,4	150/15	100	0,15
2N2905			TO-39(1)			0,6		100–300					
2N2906			TO-18(1)			0,4		40–120					
2N2907			TO-18(1)			0,4		100–300					
2N2904A	P	D	TO-39(1)	60	0,6	0,6	25	40–120	150	0,4	150/15	100	0,15
2N2905A			TO-39(1)			0,6		100–300					
2N2906A			TO-18(1)			0,4		40–120					
2N2907A			TO-18(1)			0,4		100–300					
2N3019	N	D	TO-39(1)	80	1	0,8	25	100–300	150	0,2	150/15	–	–
2N3020								40–120					
2N4036	P	C	TO-39(1)	65	1	5	(25)	20–100	150	0,65	150/15	700	0,15
2N5415	P	D	TO-39(1)	200	1	1	50	30–150	50	2,5	50/5	125	0,5
2N5416				300				30–120		2,0			

field-effect transistors

n-channel

Most of our components are backed by application publications; for this subject, ask for Application Book "Field-effect transistors".



In a charge preamplifier such as this, used with Ge(Li) radiation detector systems, FETs are chosen for their high input resistance and low noise characteristics.

Amplifiers

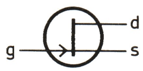
Junction

			RATINGS			CHARACTERISTICS						
type	status	case	$\pm V_{DS}$	P_{tot} at	T_{amb}	$-I_{GSS}$	I_{DSS}	$-V_{(P)GS}$	y_{fs} min	C_{rs}	F	V_n
						max	min–max	max	f = 1 kHz	typ	typ	max
			V	mW	°C	nA	mA	V	mA/V	pF	dB	µV
BC264A	D	TO-92(5) variant	30	300	25	10	2 – 4,5	> 0,5	2,5	1,2	< 2	–
BC264B							3,5– 6,5		3			
BC264C							5 – 8		3,5			
BC264D							7 – 12		4			
BF245A	D	TO-92(5) variant	30	300	75	5	2 – 6,5	8	< 6,5	1,1	1,5	–
BF245B							6 – 15					
BF245C							12 – 25					
BF246A	N	TO-92	25	300	75	5	30 – 80	14,5	8	3,5	–	–
BF246B							60 –140					
BF246C							110 –250					
BF256A	D	TO-92(5) variant	30	300	75	5	3 – 7	–	4,5	0,7	7,5	–
BF256B							6 – 13					
BF256C							11 – 18					
BFW10	D	TO-72(4)	30	300	25	0,1	8 – 20	8	< 6,5	0,6	< 2,5	–
BFW11							4 – 10	6				
BFW12	D	TO-72(4)	30	150	110	0,1	1 – 5	2,5	2	< 0,8	–	0,5
BFW13							0,2– 1,5	1,2	1			
BFW61	D	TO-72(4)	25	300	25	1,0	2 – 20	8	< 6,5	< 2	–	–
2N3823	D	TO-72(4)	30	300	25	0,5	4 – 20	8	< 6,5	< 2	< 2,5	–

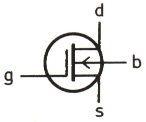
MOS

			RATINGS				CHARACTERISTICS						
type	status	case	V_{DB}	V_{DS}	P_{tot} at	T_{amb}	$\pm I_{GSS}$	$\pm I_{G1\text{-}SS}$ $\pm I_{G2\text{-}SS}$	I_{DSS}	$-V_{(P)GS}$ $-V_{(P)G1\text{-}S}$	$\lvert y_{fs} \rvert$ f = 1 kHz	C_{rs}	F
							max	max		max	min	typ	max
			V	V	mW	°C	pA	nA	mA	V	mA/V	fF	dB
BF327*	N	SOT-103	–	20	225	75	–	10	20–55	3,8	12	30	3
BFR29	D	TO-72(5)	30	–	200	25	10	–	10–40	4	6	< 700	5
BFR84*	D	TO-72(6)	–	20	300	25	–	10	20–55	3,8	12	30	3
BFS28	C	TO-72(6)	–	20	200	25	–	1	–	–	8	25	4

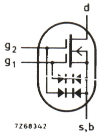
* Protected against excessive input voltage surges.



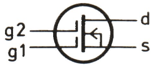
junction FET



single-gate MOS-FET



dual-gate MOS-FET protected



dual-gate MOS-FET unprotected

Symbols given are all n-channel

Switching

Junction

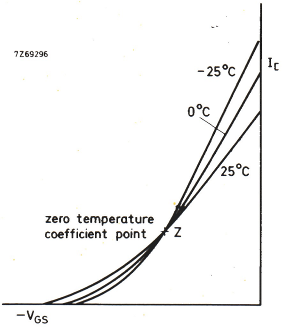
type	status	case	RATINGS $\pm V_{DS}$ V	P_{tot} at mW	T_{amb} (T_{case}) °C	CHARACTERISTICS $-I_{GSS}$ max nA	I_{DSS} min mA	$-V_{(P)GS}$ max V	$r_{ds\ on}$ max Ω	C_{rs} max pF	t_{on} max ns	t_{off} max ns
BSV78	D	TO-18(2)	40	350	25	0,25	50	11	25	5	10	10
BSV79							20	7,0	40		15	15
BSV80							10	5,0	60		15	25
2N3966	D	TO-72(4)	30	300	25	0,1	2	6	220	1,5	120	100
2N4091	D	TO-18(2)	40	1800	(25)	0,2 (I_{SGO})	30	10	30	5	25	40
2N4092							15	7,0	50		35	60
2N4093							8	5,0	80		60	80
2N4391	D	TO-18(2)	40	1800	(25)	0,1	50	10	30	3,5	15	20
2N4392							25	5,0	60			35
2N4393							5	3,0	100			50
2N4856	D	TO-18(2)	40	360	25	0,25	50	10	25	8	9	25
2N4857							20	6	40		10	50
2N4858							8	4	60		20	100
2N4859	D	TO-18(2)	30	360	25	0,25	50	10	25	8	9	25
2N4860							20	6	40		10	50
2N4861							8	4	60		20	100

MOS

type	status	case	RATINGS V_{DB} V_{SB} V	P_{tot} at mW	T_{amb} °C	CHARACTERISTICS $\pm I_{GSS}$ max pA	I_{DSX} I_{SDX} max nA	$r_{ds\ on}$ max Ω	r_{DSoff} min GΩ	C_{rs} max pF	C_{rd} max pF
BSV81	D	TO-72(5)	30	200	25	10	1	150	10	0,5	0,5

field-effect transistors

n-channel



Temperature dependence of the $I_D - V_{GS}$ characteristic of an n-channel FET

Differential amplifiers

Note: BFS . . types: matched pairs in SOT-52.
BFQ . . types: dual transistors in TO-71(1).

type	status	RATINGS individual transistor		total device	CHARACTERISTICS individual transistor			total device				
		$\pm V_{DS}$	P_{tot} (T_{amb})	P_{tot} (T_{amb})	$-I_{GSS}$	I_{DSS}	$-V_{(P)GS}$	$\|\Delta V_{GS}\|$	$\left\|\frac{d\Delta V_{GS}}{dT}\right\|$	$\left\|\Delta \frac{1}{g_{fs}}\right\|$	$\left\|\Delta \frac{g_{os}}{g_{fs}}\right\|$	CMRR
					max		max	max	max	max	max	min
		V	mW (°C)	mW (°C)	nA	mA	V	mV	µV/°C	Ω	µV/V	dB
BFQ10	D	30	250 (75)	250 (75)	0,1	0,5 - 10	3,5	5	5	6	10	100
BFQ11								10	5	6	30	90
BFQ12								10	10	12	30	90
BFQ13								10	20	12	30	90
BFQ14								15	20	12	30	90
BFQ15								20	40	20	30	90
BFQ16								50	50	30	100	80
BFS21	C	30	300 (25)	30 (100)		> 1	6	20	75	15	1000	60
BFS21A								10	40	7,5	500	66

dual transistors

Differential amplifiers — polarity n-p-n

Dual transistors in TO-71(2).

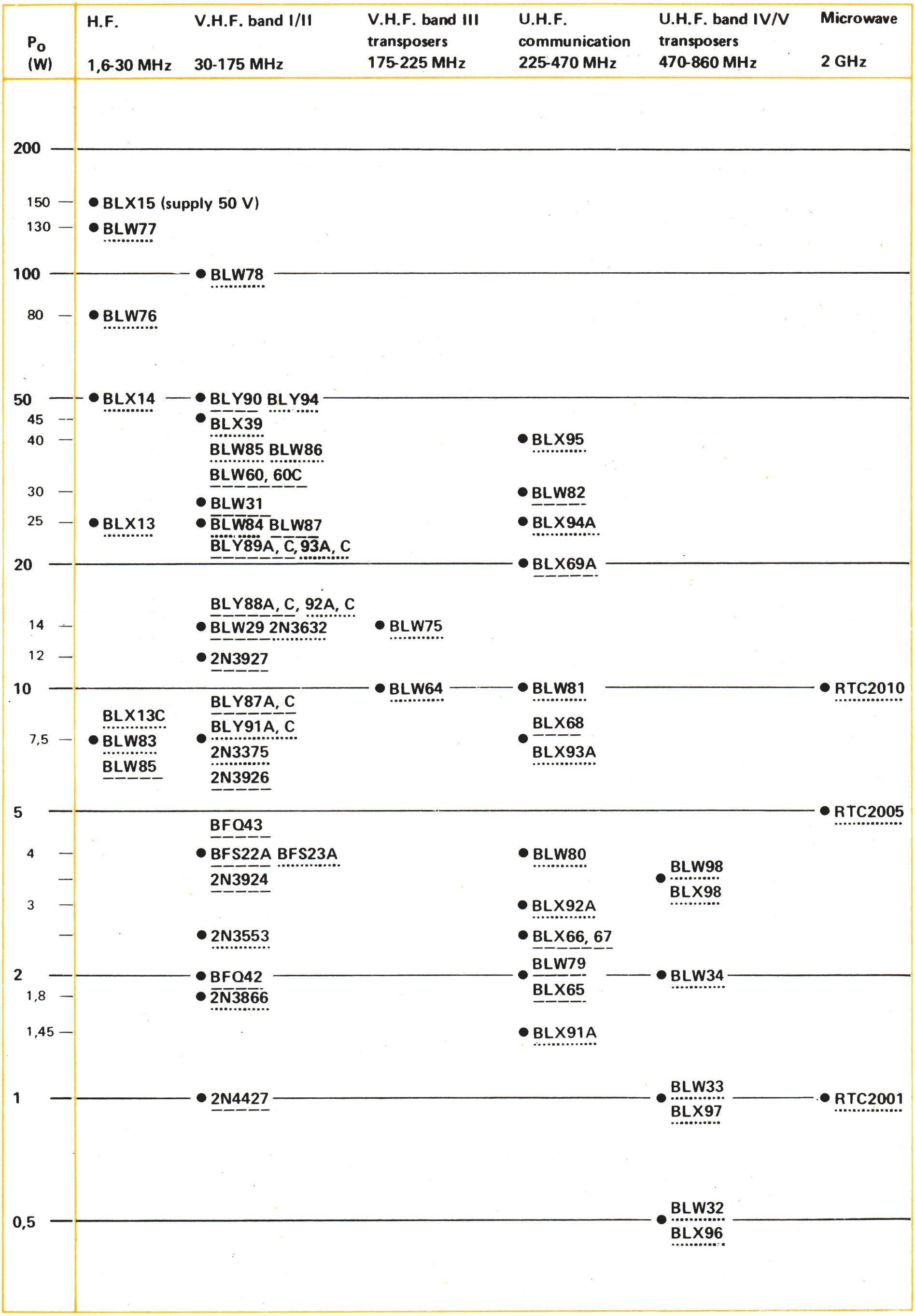
type	status	RATINGS individual transistor			CHARACTERISTICS individual transistor				total device			
		V_{CEO}	I_C	P_{tot} (T_{amb})	h_{FE}	at I_C	F	f_T	$\frac{I_{1C}}{I_{2C}}$	$V_{1BE}-V_{2BE}$	$\left\|\frac{\Delta V}{\Delta T}\right\|$	$\left\|\frac{\Delta I}{\Delta T}\right\|$
							max	min		max	max	max
		V	mA	mW (°C)	min — max	mA	dB	MHz		mV	µV/°C	nA/°C
											T_{amb} = −20 to +90 °C	
BCY87	D	40	30	150 (25)	100 — 450	0,05	3	50	0,9 - 1,11	3	3	0,5
BCY88					120 — 600	0,5	4		0,8 - 1,25	6	6	2
BCY89					100 — 600	10	4		0,67 - 1,5	10	10	10

BFQ10 to 16; see above

transmitting transistors

selection guide

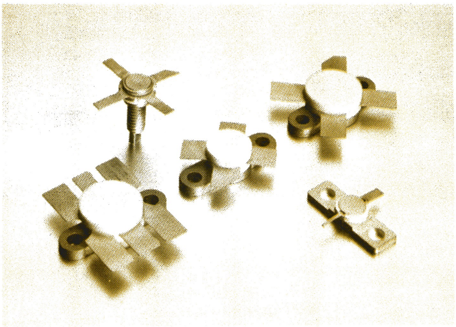
------ supply 12,5 V
.... supply 28 V



Po (W)	H.F. 1,6-30 MHz	V.H.F. band I/II 30-175 MHz	V.H.F. band III transposers 175-225 MHz	U.H.F. communication 225-470 MHz	U.H.F. band IV/V transposers 470-860 MHz	Microwave 2 GHz
200						
150	● BLX15 (supply 50 V)					
130	● BLW77					
100		● BLW78				
80	● BLW76					
50	● BLX14	● BLY90 BLY94				
45		● BLX39				
40		BLW85 BLW86		● BLX95		
		BLW60, 60C				
30		● BLW31		● BLW82		
25	● BLX13	● BLW84 BLW87 BLY89A, C, 93A, C		● BLX94A		
20				● BLX69A		
		BLY88A, C, 92A, C				
14		● BLW29 2N3632	● BLW75			
12		● 2N3927				
10			● BLW64	● BLW81		● RTC2010
7,5	BLX13C ● BLW83 BLW85	BLY87A, C BLY91A, C ● 2N3375 2N3926		BLX68 ● BLX93A		
5		BFQ43				● RTC2005
4		● BFS22A BFS23A		● BLW80		
		2N3924			● BLW98 BLX98	
3				● BLX92A		
		● 2N3553		● BLX66, 67		
2		● BFQ42		BLW79 ● BLX65	● BLW34	
1,8		● 2N3866				
1,45				● BLX91A		
1		● 2N4427			BLW33 ● BLX97	● RTC2001
0,5					BLW32 ● BLX96	

transmitting transistors

transposers and microwave



New tv transposer types **BLW32 - BLW33 - BLW34** for application in band IV/V

- ○ Au-Au metallization for high reliability
- ○ high power gain offering cheaper line-up
- ○ sophisticated ion-implantation technology
- ○ modern encapsulation giving optimum heatsinking
- ○ complete line-up with small-signal driver transistors

Transistors for transposers – polarity n-p-n

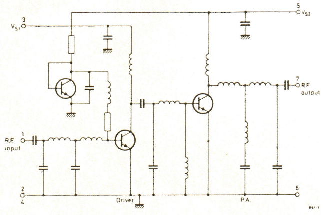
			RATINGS				CIRCUIT VALUES					
type	status	case	V_{CEO}	I_{CM}	P_{tot} at	T_h	f_{vision}	$P_{o\,sync}$ * min	G_p min	d_{im} *	V_{CE}	I_C
			V	A	W	°C	MHz	W	dB	dB	V	A
BLW64	D	SOT-56	32	9	40	70	224,25	10	9,5	–55	25	1,6
BLW75	D	SOT-105	32	12	60	70	224,25	14	8	–55	25	2,4
BLX96	C	SOT-48(3)	27	1	6,25	100	860	0,5	6	–60	25	0,25
BLX97		SOT-48(3)		2	12,5	100		1	5,5			0,5
BLX98		SOT-48(2)		4	21,5	70		3,5	5			0,85
BLW98	N	SOT-122	27	4	21,5	70	860	3,5	6,5	–60	25	0,85
BLW32	N	SOT-122	30	0,8	5	70	860	0,5	11	–60	25	0,125
BLW33				1,5	10			1	10			0,25
BLW34				3	17,5			2	9			0,5

* Three-tone test method.

Transistors for microwave

		CIRCUIT VALUES				RATINGS			
type	status	f	P_o	G_p typ	η typ	V_{CEO}	I_{CM}	mode of operation	case
		GHz	W	dB	%	V	A		
RTC2001	N	2	1	9	35	36	1	CW	FO-53
RTC2005	N	2	5	7	45	36	3	CW	FO-53
RTC2010	N	2	10	6	40	36	4,5	CW	FO-53

modules

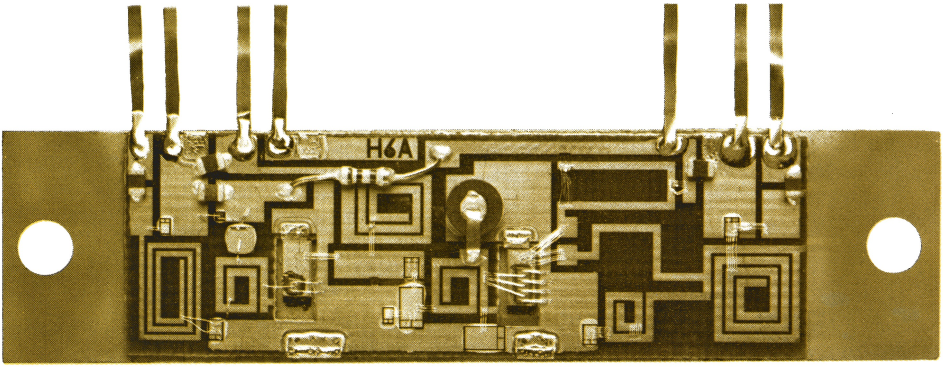


Circuit of the v.h.f. module

Modules c.w. operation – polarity n-p-n

type	status	case	CIRCUIT VALUES V_B V	f MHz	P_D max W	P_L W	η min %
BGY22 **BGY22A**	D	SOT-75A	13,5 12,5	380 – 512 420 – 480	0,05	2,5	40
BGY23 **BGY23A**	D	SOT-75A	13,5 12,5	380 – 480 420 – 480	2,5	7	60

type number status		**BGY32** D	**BGY33** D	**BGY35** D	**BGY36** D	
Frequency range		68 to 88	80 to 108	132 to 156	148 to 174	MHz
Drive power	nom	100	100	150	150	mW
Output power	min	18	18	18	18	W
	typ	23	22	22	21	W
Supply voltages						
V_{B1} and V_{B2}	nom	12,5	12,5	12,5	12,5	V
Input impedance	nom	50	50	50	50	Ω
Output load impedance	nom	50	50	50	50	Ω
Heatsink temperature (operating)	max	90	90	90	90	°C
Input VSWR	typ	1,5	1,5	1,5	1,5	
Harmonic output	max	–25	–25	–25	–25	dB



transmitting transistors

Our data handbooks are unique in the amount of information they contain.
For standard operating conditions:

- read-off curves for power gain, input impedance, output impedance versus operating frequency
- circuit schematic
- print layout
- component mounting diagram
- VSWR curves
- d.c. SOAR curve
- r.f. SOAR curve

For non-standard operating conditions we supply computer-aided design figures.

C.W. operation — polarity n-p-n

			CIRCUIT VALUES				RATINGS				
supply voltage V	type	status	f MHz	P_o typ W	G_p min dB	η min %	V_{CEO} V	I_{CM} A	P_{tot} W	at T_{mb} (T_{case}) °C	case
12,5 or 13,5	**2N4427**	D	175	1	10	50	20	0,4	3,5	25	TO-39(1)
	2N3924	C	175	4	6	70	18	1,5	7	25	TO-39(1)
	2N3926	C	175	7	5,4	70	18	3	11,6	25	TO-60
	2N3927	C	175	12	4,8	80	18	4,5	23	25	TO-60
	BFS22A	D	175	4	8	60	18	2,25	8	25	TO-39(1)
	BLY87A	D	175	8	9	70	18	3,75	17,5	25	SOT-48(2)
	BLY88A	D	175	15	7,5	65	18	7,5	32	25	SOT-48(2)
	BLY89A	D	175	25	6	70	18	10	70	25	SOT-56
	BLW60	D	175	45	5,5	75	18	20	65	70	SOT-56
	BLY90	D	175	50	5	75	18	20	130	25	SOT-55
	BLY87C	C	175	8	9	70	18	3,75	17,5	25	SOT-120
	BLY88C	C	175	15	8	65	18	7,5	32	25	SOT-120
	BLY89C	C	175	25	6	70	18	12	73	25	SOT-120
	BLW60C	C	175	45	5,5	75	18	22	100	25	SOT-120
	BFQ42	D	175	2	11	50	18	1,5	6,75	25	TO-39(1)
	BFQ43	D	175	4	12	60	18	3,75	10	(25)	TO-39(1)*
	BLW29	D	175	14	10	60	18	8	45	25	SOT-120
	BLW31	D	175	28	9	60	18	15	70	25	SOT-120
	BLW87	D	175	25	6	70	18	12	76	25	SOT-123
	BLW85	D	175	45	5	75	18	22	105	25	SOT-123
	BLX65	D	470	2	6	65	18	2	3	(90)	TO-39(1)
	BLX66	D	470	2,5	8,5	65	18	2	4	90	SOT-48(4)
	BLX67	D	470	2,5	8,5	65	18	2	4,5	90	SOT-48(3)
	BLX68	D	470	7	5	65	18	4	10	70	SOT-48(3)
	BLX69A	D	470	20	4	65	18	10	50	25	SOT-48(2)
	BLW79	N	470	2	9	60	17	1,5	8,5	70	SOT-122
	BLW80	N	470	4	8	60	17	3	17	25	SOT-122
	BLW81	N	470	10	6	60	17	7,5	40	25	SOT-122
	BLW82	N	470	30	5	60	18	15	70	25	SOT-119

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* Emitter to case.
** Studless.

Full range of transistors for h.f., v.h.f. and u.h.f. with output powers up to 150 W.

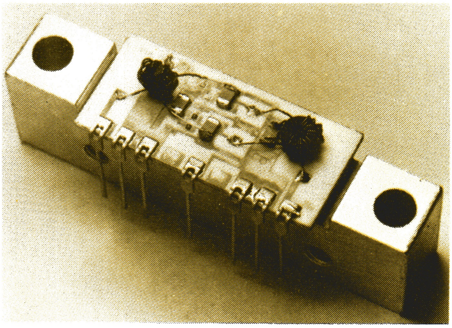
SSB or C.W. operation — polarity n-p-n

			CIRCUIT VALUES				RATINGS					
supply voltage V	type	status	f MHz	P_o W	G_p min dB	η min %	V_{CEO} V	I_{CM} A	P_{tot} W	at T_h °C	mode of operation	case
28	**BLX13**	D	28	25	18	35	36	6	62,5	25	SSB	SOT-56
	BLX14	D	28	50	13	35	36	12	88	25	SSB	SOT-55
	BLX13C	D	28	8	18	—	36	6	70	25	SSB	SOT-120
	BLW83	D	28	8	20	—	36	9	76	25	SSB	SOT-123
	BLW76	D	28	80	13	35	35	20	140	25	SSB	SOT-121A
	BLW77	D	28	130	12	37,5	35	30	245	25	SSB	SOT-121A
	BLX13	D	70	25	17	60	36	6	62,5	25	CW	SOT-56
	BLX14	D	70	50	7,5	55	36	12	88	25	CW	SOT-55
	2N3866	D	100	1,8	15,5	60	30	0,4	5	25	CW	TO-39(1)
	2N3375	D	100	7,5	8,8	65	40	1,5	11,6	25	CW	TO-60
	BLW78	D	150	100	6	70	35	25	160	25	CW	SOT-121A
	2N3553	C	175	2,5	10	50	40	1	7	25	CW	TO-39(1)
	2N3375	C	175	7,5	7	65	40	1,5	11,6	25	CW	TO-60
	2N3632	C	175	13,5	6	70	40	3	23	25	CW	TO-60
	BFS23A	D	175	4	10	65	36	1,5	8	25	CW	TO-39(1)
	BLY91A	D	175	8	12	65	36	2,25	17,5	25	CW	SOT-48(2)
	BLY92A	D	175	15	10	65	36	4,5	32	25	CW	SOT-48(2)
	BLY93A	D	175	25	9	60	36	9	70	25	CW	SOT-56
	BLY94	D	175	50	7	65	36	12	130	25	CW	SOT-55
	BLY91C	D	175	8	12	65	36	2,25	18	25	CW	SOT-120
	BLY92C	D	175	15	10	65	36	4,5	32	25	CW	SOT-120
	BLY93C	D	175	25	9	60	36	9	70	25	CW	SOT-120
	BLX39	D	175	45	8	65	36	12	50	70	CW	SOT-120
	BLW84	D	175	25	9	60	36	9	76	25	CW	SOT-123
	BLW86	D	175	45	7,5	65	36	12	105	25	CW	SOT-123
	BLX91A	D	470	1,45	12,6	60	33	0,8	4	70	CW	SOT-48(3)
	BLX92A	D	470	3	11,7	66	33	2	6	70	CW	SOT-48(3)
	BLX93A	D	470	8	9	75	33	3	12,5	70	CW	SOT-48(3)
	BLX94A	D	470	25	6	55	30	6	50	25	CW	SOT-48(2)
	BLX95	D	470	40	4,5	60	30	10	76	25	CW	SOT-56
50	**BLX15**	D	28	150	14	37,5	53	20	195	25	SSB	SOT-55

wideband transistors

selection guide

Wideband transistors for MATV and CATV, with long-term reliability.



CATV module BGY37.

BFQ34 and **BFR94** meet all NCTA cross-modulation and DIN intermodulation requirements. We guarantee 12-channel cross-modulation distortion to NCTA standard (> −105 dB) and three-tone intermodulation according to DIN norm.

Islanded collector area prevents "hot spots" and diffused emitter ballast resistors (20) avoid second breakdown, hence rugged devices.

Ti-Pt-Au metallization:
Gold for conduction;
Titanium for adhesion;
Platinum as migration barrier.

Application	**Recommended types**
wideband aerial amplifiers band I up to V (40-860 MHz) wideband distribution amplifiers	BFQ22 to 24, BFQ32, BFQ34 BFR34, BFR90, 91, BFR95, 96, BFW30, BFW92, 93, BFX89, BFY90
low noise wideband amplifiers in measuring equipment r.f. amplifiers and mixers for communication systems (microwave link radar i.f. amplifiers)	BFQ22 to 24, BFQ34 BFR49, BFR90, 91, BFY90
high output channel and band aerial amplifiers in driver and final stages channel amplifiers in CATV and MATV wideband amplifiers	BFQ34, BFR64, 65, BFR95 BFW16A, 17A
output and driver stages in CATV wideband amplifiers	BFQ34, BFR94

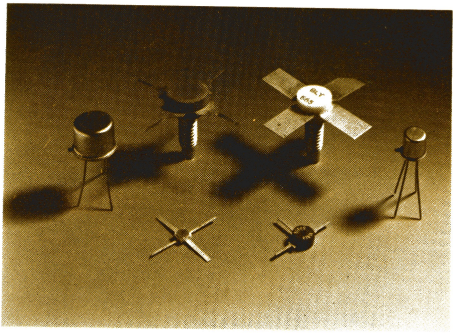
Corresponding types in SOT-23 or SOT-89

	SOT-23	SOT-89
BFQ23	BFT93	–
BFQ34	–	BFQ18
BFR90	BFR92	–
BFR91	BFR93	–
BFR96	–	BFQ19
BFW16A	–	BFQ17
BFW30	BFR53	–
BFY90	BFS17	–

CATV power module

			CIRCUIT VALUES						
type	status	case	V_B V	P_{tot} max W	T_{case} max °C	G_p dB	flatness 40 to 300 MHz dB	V_o at −60 dB distortion dBmV	F max dB
BGY37	N	SOT-115	24	5,3	90	16,4	± 0,1	65	7

abridged data



Wideband transistors.

type all n-p-n	status	case	f MHz	CIRCUIT VALUES (TYP) P_o * mW	 G_p (G_{UM}) dB	 V_{CE} V	 I_C mA	RATINGS V_{CEO} V	 I_{CM} mA	 P_{tot} mW	CHARACTERISTICS h_{FE}	 f_T typ GHz	 F typ dB
BFX89	D	TO-72(1)	200 800	6	22 7	10	8	15	50	200	20-150	1,2	3,3 7,0
BFW92	D	SOT-37(2)	200 800	8	23 11	10	10	15	50	190	20-150	1,6	4 at 500 MHz
BFY90	D	TO-72(1)	200 800	12	23 8	10	14	15	50	200	25-150	1,4	2,5 5,5
BFW30	D	TO-72(1)	200 800	15	21 7,5	5	30	10	100	250	> 25	1,6	< 5,0 at 500 MHz
BFW93	D	SOT-37(2)	200 800	15	(22) (10,5)	5	30	10	100	190	> 25	1,7	< 5,0 at 500 MHz
BFW16A	D	TO-39(1)	200 800	150 90	16 6,5	18	70	25	300	1500	> 25	1,2	< 6,0 –
BFW17A	C	TO-39(1)	200	150	16	18	70	25	300	1500	> 25	1,1	–
BFR64	D	SOT-48(3)	200 800	150 90	16 6,5	20	70	25	500	3500	> 25	1,2	6,0 –
BFR65	D	SOT-48(3)	200 800	450 –	19 4,5	20	200	25	1000	5000	> 30	> 1,2	– –

type	polarity	status	case	CHARACTERISTICS (TYP) d_{im}** dB	at conditions $f_{(p+q-r)}$ MHz	 V_{CE} V	 I_C mA	 V_o mV	G_{UM} typ dB	F typ dB	at f MHz
BFQ22	N	D	TO-72(1)	−60	493,25	5	30	300	16,5	1,9	500
BFQ23	P	D	SOT-37(2)	−60	493,25	5	30	300	16,5	2,4	500
BFQ24	P	D	TO-72(1)	−60	493,25	5	30	300	16,5	2,4	500
BFQ32	P	D	SOT-37(2)	−60	493,25	10	50	500	14	3,75	500
BFQ34	N	D	SOT-122	−60	793,25	15	120	1200	16	8	500
BFR49	N	D	SOT-100	–	–	10	14	–	17	2,5	1000
BFR90	N	D	SOT-37(2)	−60	493,25	10	14	150	19,5	2,4	500
BFR91	N	D	SOT-37(2)	−60	493,25	5	30	300	16,5	1.9	500
BFR94	N	D	SOT-48(3)	−60	493,25	20	90	700	13,5	5	200
BFR95	N	D	TO-39(1)	−61	194,25	18	80	1000	13,5	9	200
BFR96	N	D	SOT-37(2)	−60	493,25	10	50	500	16	3,3	500

* VSWR at output < 2 measured at $f_{(2q-p)}$.
f_p = 202 MHz, f_q = 205 MHz or f_p = 798 MHz, f_q = 802 MHz.

** Intermodulation distortion measured according to DIN three-tone test.

microminiatures

devices for thick and thin-film circuits

code for substrate dimensions

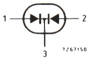
quoted values are max., unless
otherwise specified

Diodes

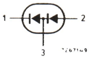
High speed switching

type	code on case	status	case	RATINGS V_R V	I_F mA	I_{FRM} mA	CHARACTERISTICS t_{rr}* ns	C_d pF	V_F at I_F 1 mA mV	10 mA mV	50 mA mV	100 mA mV
BAV70	A4							1,5				
BAV99	A7	D	SOT-23	70	100	200	6	1,5	715	855	1100	1300
BAW56	A1							2				

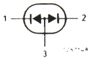
BAV70



BAV99



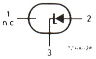
BAW56



Voltage regulators

type	status	case	P_{tot} mW	voltage tolerance (±)%	I_{FRM} mA	I_{ZRM} mA
BZX84-series	D	SOT-23	200(a)		200	200

BZX84

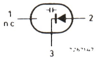


suffix	code on case	V_{Znom}** V	r_{diff}** f = 1 kHz Ω	S_Z** mV/°C	suffix	code on case	V_{Znom}** V	r_{diff}** f = 1 kHz Ω	S_Z** mV/°C
C4V7	Z1	4,7	80	0,2	C20	Y7	20	55	18,0
C5V1	Z2	5,1	60	1,2	C22	Y8	22	55	20,0
C5V6	Z3	5,6	40	2,5	C24	Y9	24	70	22,0
C6V2	Z4	6,2	10	3,7	C27	Y10	27	80	25,3
C6V8	Z5	6,8	15	4,5	C30	Y11	30	80	29,4
C7V5	Z6	7,5	15	5,3	C33	Y12	33	80	33,4
C8V2	Z7	8,2	15	6,2	C36	Y13	36	90	37,4
C9V1	Z8	9,1	15	7,0	C39	Y14	39	130	41,2
C10	Z9	10	20	8,0	C43	Y15	43	150	46,6
C11	Y1	11	20	9,0	C47	Y16	47	170	51,8
C12	Y2	12	25	10,0	C51	Y17	51	180	57,2
C13	Y3	13	30	11,0	C56	Y18	56	200	63,8
C15	Y4	15	30	13,0	C62	Y19	62	215	71,6
C16	Y5	16	40	14,0	C68	Y20	68	240	79,8
C18	Y6	18	45	16,0	C75	Y21	75	255	88,6

Variable capacitance

type	code on case	status	case	RATINGS V_R V	CHARACTERISTICS C_d pF	@	V_R V	C_d ratio @ typ	V/..V	r_D Ω	@	C_d pF
BBY31	S1	D	SOT-23	28	1,8-2,8		25	5	3/25	1,2		9

BBY31

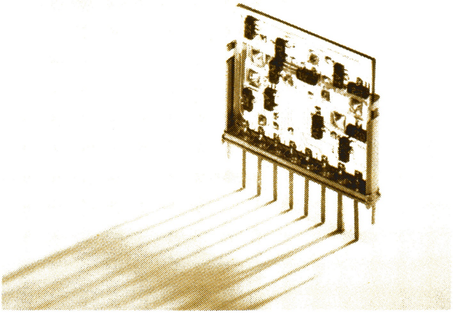


* I_F = 10 mA to I_R = 10 mA, R_L = 100 Ω. Measured at I_R = 1 mA.
** C4V7 to C24 at I_Z = 5 mA, C27 to C75 at I_Z = 2 mA.

The P_{tot} rating of these microminiature devices depends on the dimensions of the ceramic substrate on which each device is mounted, as well as on T_{amb}.

Dimensions of the ceramic substrate are indicated by a code letter between brackets placed after the P_{tot} value.

Code (a): 7 mm x 5 mm x 0,5 mm.
(b): 15 mm x 15 mm x 0,5 mm.
(c): 15 mm x 10 mm x 0,5 mm.
(d): area = 2,5 cm^2; thickness = 0,7 mm.
T_{amb} = 25 °C, unless otherwise specified.

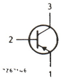


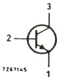
Transistors

Polarity indication P = p-n-p
N = n-p-n

Low frequency

				RATINGS				CHARACTERISTICS					
type	code on case	polarity	status case	V_{CBO} (V_{CES}) V	V_{CEO} V	I_C mA	P_{tot} mW	h_{FE} min – max	at I_C mA	F max dB	f_T typ MHz	V_{CEsat} max mV	at I_C mA
general purpose, low level													
BCW29	C1	P	D SOT-23	30	20	100	200(a)	120 – 260	2	10	150	300	10
BCW30	C2	P						215 – 500			150	300	
BCW31	D1	N						110 – 220			300	250	
BCW32	D2	N						200 – 450			300	250	
BCW33	D3	N						420 – 800			300	250	
BCW69	H1	P	D SOT-23	50	45	100	200(a)	120 – 260	2	10	150	300	10
BCW70	H2	P						215 – 500			150	300	
BCW71	K1	N						110 – 220			300	250	
BCW72	K2	N						200 – 450			300	250	
general purpose – also for switching and driver applications (industrial)													
BCX17	T1	P	D SOT-23	(50)	45	500	310(b)	100 – 600	100		100	620	500
BCX18	T2	P		(30)	25						100		
BCX19	U1	N		(50)	45						200		
BCX20	U2	N		(30)	25						200		
BCX51	–	P	D SOT-89	45	45	1000	1000(d)	40 – 250	150		50	500	500
BCX52	–	P		60	60			40 – 160					
BCX53	–	P		100	80			40 – 160					
BCX54	–	N	D SOT-89	45	45	1000	1000(d)	40 – 250	150		130	500	500
BCX55	–	N		60	60			40 – 160					
BCX56	–	N		100	80			40 – 160					





Note: BCW29 is complementary to	BCW31
BCW30	BCW32
BCW69	BCW71
BCW70	BCW72
BCX17	BCX19
BCX18	BCX20
BCX51	BCX54
BCX52	BCX55
BCX53	BCX56

microminiatures

devices for thick and thin-film circuits

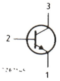
code for substrate dimensions

Transistors

Polarity indication P = p-n-p
N = n-p-n

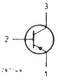
High frequency — polarity n-p-n

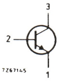
type	code on case	status case	RATINGS V_{CEO} V	I_C mA	P_{tot} mW	CHARACTERISTICS h_{FE} min – max	at I_C mA	F typ dB	at f MHz	f_T typ MHz	C_{re} typ pF	at f MHz
BFS18	F1	D SOT-23	20	30	200(a)	35 – 125	1	4	100	200	0,85	1
BFS19	F2			30		65 – 225	1	4	100	260	0,85	
BFS20	G1			25		40	7	–	–	450	0,35	



Wide-band

type	polarity	code on case	status	case	RATINGS V_{CEO} V	I_{CM} (I_C) mA	P_{tot} mW	CHARACTERISTICS h_{FE} min	f_T typ GHz	F typ dB	G_{UM} typ dB	at f MHz	and V_{CE} V	and I_C mA
BFQ17	N	–	D	SOT-89	25	300	1000(d)	25	1,2	< 6	–	–	–	–
BFQ18					25	300	1000(d)	30	3,5	8				
BFQ19					15	150	500(d)*	30	5	3,3				
BFR53	N	N1	D	SOT-23	10	100	180(c)▲	25	2	< 5	22 10,5	200 800	5	30
BFR92	N	P1	D	SOT-23	15	(25)	180(c)▲	25	5	2,4	18	500	10	14
BFR93		R1			12	(35)				1,9	16,5		5	30
BFS17	N	E1	D	SOT-23	15	50	200(a)	20-150	1	4,5	–	–	–	–
BFT25	N	V1	D	SOT-23	5	5	30(c)●	20	2,3	3,8	18	500	1	1
BFT92	P	W1	D	SOT-23	15	35	180(c)▲	20	5	2,7	18	500	10	14
BFT93		X1			12	50				2,4	16,5		5	30



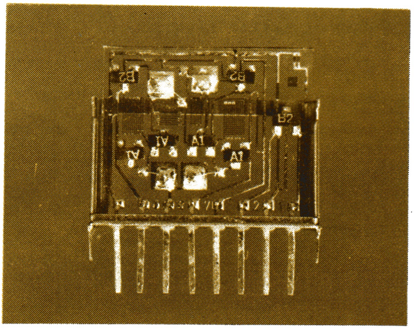


* T_{amb} = 87,5 °C.
▲ T_{amb} = 60 °C.
● T_{amb} = 135 °C.

The P_{tot} rating of these microminiature devices depends on the dimensions of the ceramic substrate on which each device is mounted, as well as on T_{amb}.

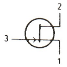
Dimensions of the ceramic substrate are indicated by a code letter between brackets placed after the P_{tot} value.

Code (a): 7 mm x 5 mm x 0,5 mm.
(b): 15 mm x 15 mm x 0,5 mm.
(c): 15 mm x 10 mm x 0,5 mm.
(d): area = 2,5 cm^2 ; thickness = 0,7 mm.
T_{amb} = 25 °C, unless otherwise specified.



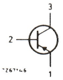
Field-effect
general purpose — low level amplifiers

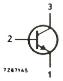
type	code on case	status	case	RATINGS ± V_{DS} V	P_{tot} mW	CHARACTERISTICS $-I_{GSS}$ max nA	I_{DSS} mA	$-V_{(P)GS}$ max V	y_{fs} at 1 kHz max mA/V	C_{rs} max pF	V_n max µV
BFR30	M1	D	SOT-23	25	200(a)	0,2	4-10	5	4	1,5	0,5
BFR31	M2						1- 5	2,5	4,5		



Switching

type	code on case	polarity	status	case	RATINGS V_{CEO} V	I_C mA	P_{tot} mW	CHARACTERISTICS h_{FE} min–max	at I_C mA	V_{CEsat} max V	at I_C mA	t_{off} max ns	at I_C mA
BSV52	B2	N	D	SOT-23	12	100	200(a)	40–120	10	0,25	10	18	10
BSS63	T3	P	N	SOT-23	100	100	200(a)	30	25	0,25	25	–	–
BSS64	U3	N			80			20	4	3	50	1000	15
BSR12	B5	P	D	SOT-23	15	100	200(a)	30–120	50	190	50	30	30

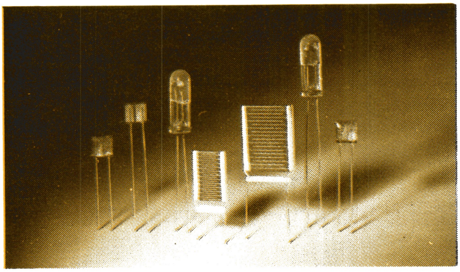




Video black and white and colour tv.

type	polarity	status	case	RATINGS V_{CBO} V	V_{CEO} V	I_C mA	P_{tot} W	at T_{amb} °C	CHARACTERISTICS h_{FE} min	at I_C mA	f_T MHz
BF622	N	D	SOT-89	250	250	20	1(d)	25	50	25	> 60
BF623	P										

photoconductive devices



CdS cells

type	status	P max mW	V max V	r_{do} min MΩ	r_{lo}* typ kΩ
hermetically sealed — all glass shock and vibration resistant					
ORP60	D	70	350	200	60
ORP61	D	70	350	200	60
ORP66	D	70	350	200	< 55
ORP62	D	100	350	150	45
ORP68	D	100	350	150	64
ORP69	D	100	350	100	30

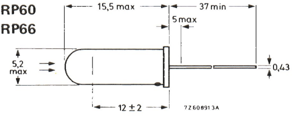
CdS cells

type	status	P max mW	V max V	r_{do} min MΩ	r_{lo}* typ kΩ
plastic encapsulated					
RPY58A	D	100	50	0,2	0,6
RPY71	D	50	50	0,6	2,4-6
laquered; flat types					
RPY82	C	300	100	6	0,95
RPY85	C	500	200	9	1,15
RPY84	C	750	400	9	1,15

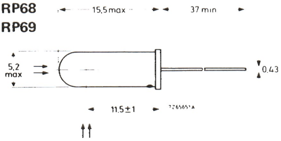
* At 50 lux; $T_c = 2700$ K.

dimensions in mm

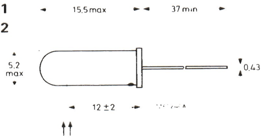
ORP60
ORP66


15,5 max
37 min
5 max
5,2 max
0,43
12 ± 2
7Z60891 3A

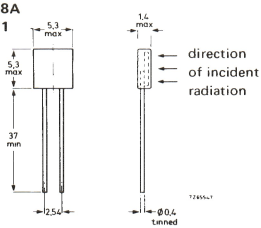
ORP68
ORP69


15,5 max
37 min
5,2 max
0,43
11,5 ± 1
7Z65651A

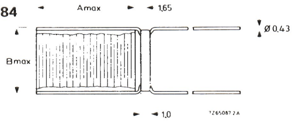
ORP61
ORP62


15,5 max
37 min
5,2 max
0,43
12 ± 2

RPY58A
RPY71

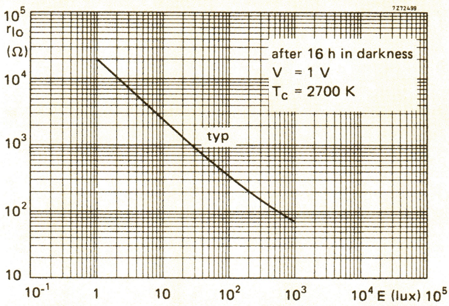

5,3 max
1,4 max
5,3 max
37 min
direction of incident radiation
2,54
Ø 0,4 tinned
7Z65547

RPY82
RPY85
RPY84

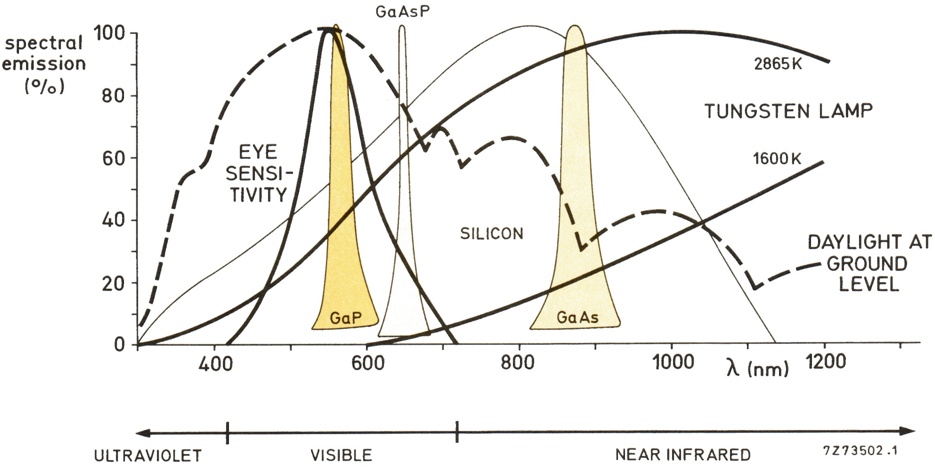

A max
1,65
Ø 0,43
B max
1,0
7Z65087 2A

	A	B	max thickness
RPY82	11,5	8,8	1,8
RPY85	15	12,6	2,2
RPY84	29,5	12,6	2,2

CdS cells are non-junction devices that exhibit much higher sensitivity than silicon junction devices and have a dissipation high enough to drive a relay direct. Their sensitivity suits them for such applications as camera shutter control, automatic brightness and contrast control in tv receivers, and their high through-put makes them ideal for street lighting control. Other applications include flame detection, and industrial presence and position detection.



Response of RPY58A.

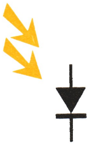


photosensitive devices

These devices are mainly used in combination with a light source for go/no-go detection as in card readers, barriers, and industrial safety devices. For weak light signals the BPX94 is recommended by reason of its high signal-to-noise ratio, and for light-activated switch applications, the BPX66P.

Diodes

λ_{peak} typ 800 nm

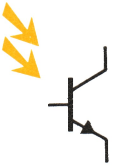


type	status	RATINGS V_R V	 I_F mA	 P_{tot} mW	CHARACTERISTICS N* typ nA/lx	 $I_{R(D)}$ max µA	 at V_R V
BPW34	N	32	–	150	70**	30	10
BPX40	D	18	5	–	13	0,5	15
BPX41	D	18	10	–	38	1	15
BPX42	D	12	50	–	140	5	10
BPX94	D	18	–	300	8	typ 10^{-4}	1

* V_R = 0; T_c = 2700 K. ** V_R = 5 V; T_c = 2856 K.

Transistors — polarity n-p-n

λ_{peak} typ 800 nm

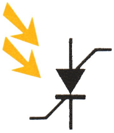


type	status	RATINGS V_{CEO} V	 I_C mA	 P_{tot} mW	CHARACTERISTICS N µA/lx	 at V_{CE}▲ V	 t_{on} max µs	 max dark current▲ µA	 at V_{CE} V
BPW22	D	30	25	50	> 5,7	5	–	0,1	20
BPX25	D	32	100	300	> 5	6	6	0,5	24
BPX29					> 0,25		10		
BPX70	D	30	25	180	0,1 –0,7	5	13	0,1	20
BPX70C					0,1 –0,3				
D					0,2 –0,4				
E					0,3 –0,7				
BPX71	D	50	20	50	0,18–3,56	5	50	0,025	30
BPX71-201					0,18–0,71				
202					0,48–1,19				
203					0,95–1,9				
204					1,66–3,56				
BPX72	D	30	25	180	0,5 –3	5	26	0,1	20
BPX72C					0,5 –1,2				
D					0,85–2				
E					1,4 –3				
BPX95	D	30	25	100	> 5	5	▲▲	0,1	20

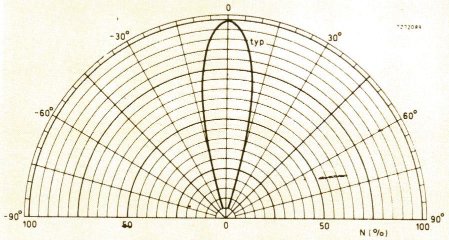
▲ I_B = 0. ▲▲ t_r = 3 µs.

Light-activated switch (SCS)

λ_{peak} typ 800 nm

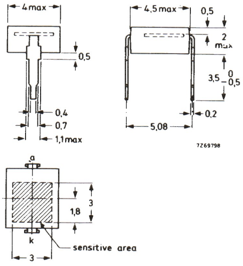


type	status	RATINGS V_{AK} V_{KA} V	 I_A mA	 I_{ARM} t = 10 µs; δ = 0,01 A	CHARACTERISTICS $E_{e\,tr}$ min mW/cm²	 t_{on} typ µs
BPX66P	C	70	150	2,5	1,5	30

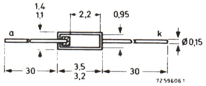


Polar response of relative sensitivity of BPX95.

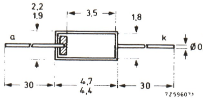
BPW34


4 max
4,5 max
0,5
2 max
0,5
3,5
0
-0,5
0,4
0,7
1,1 max
0,2
5,08
7Z69798
a
k
3
1,8
3
sensitive area

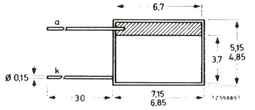
BPX40


1,4
1,1
2,2
0,95
a
k
Ø 0,15
30
3,5
3,2
30
7Z59606.1

BPX41

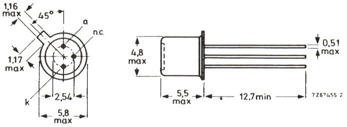

2,2
1,9
3,5
1,8
a
k
Ø 0,15
30
4,7
4,4
30
7Z59607.1

BPX42

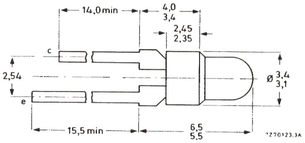

6,7
a
5,15
4,85
3,7
Ø 0,15
k
30
7,15
6,85
7Z59889.1

Note: BPX40 to 42 are unencapsulated.

BPX94 in **TO-18**
(except for window)

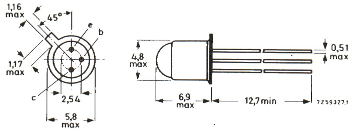

1,16 max
45°
a
n.c.
1,17 max
k
2,54
5,8 max
4,8 max
0,51 max
5,5 max
12,7 min
7Z67455.2

BPW22
in SOD-53B

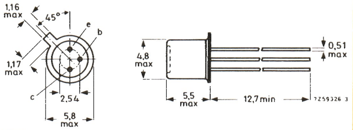

14,0 min
4,0
3,4
2,45
2,35
c
2,54
e
Ø 3,4
3,1
15,5 min
6,5
5,5
7Z70123.3A

BPX25 in TO-18 (except for lens)
collector to case

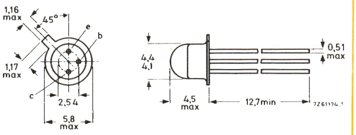
dimensions in mm


1,16 max
45°
e
b
1,17 max
c
2,54
5,8 max
4,8 max
0,51 max
6,9 max
12,7 min
7Z59327.1

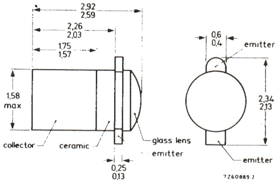
BPX29 in TO-18 (except for window)
collector to case


1,16 max
45°
e
b
1,17 max
c
2,54
5,8 max
4,8 max
0,51 max
5,5 max
12,7 min
7Z59326.3

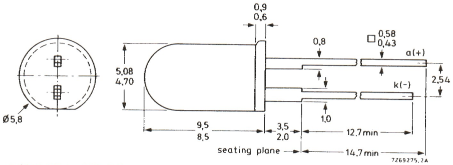
BPX70 and BPX72
in SOT-70A


1,16 max
45°
e
b
1,17 max
c
2,54
5,8 max
4,4
4,1
0,51 max
4,5 max
12,7 min
7Z61174.1

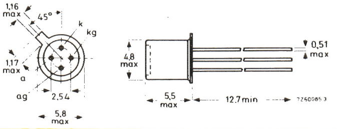
BPX71
in DO-31


2,92
2,59
2,26
2,03
1,75
1,57
0,6
0,4
emitter
1,58 max
2,34
2,13
collector
ceramic
glass lens
emitter
emitter
0,25
0,13
7Z60889.2

BPX95 in SOD-39D


0,9
0,6
0,8
0,58
0,43
a(+)
5,08
4,70
2,54
k(-)
Ø 5,8
1,0
9,5
8,5
3,5
2,0
12,7 min
seating plane
14,7 min
7Z69275.2A

BPX66P in TO-72
(except for window)


1,16 max
45°
k
kg
1,17 max
a
ag
2,54
5,8 max
4,8 max
0,51 max
5,5 max
12,7 min
7Z60065.3

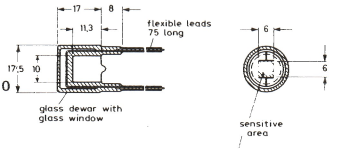
infrared detectors

The detectors shown on this page are our standard range and are not representative of the numerous types we produce for specialist applications and to customer's specifications. The devices shown here are, except one, room temperature devices, whereas most of the non-standard types are dewar cooled. For further information contact our local sales engineer.

type	status	operating temp. K	λ_{peak} μm	λ μm	D * typ cm Hz^{½}W^{-1}
61SV	D	293-193	2,2	0,3-3,5	4 x 10^{10}
RPY76A	D	293	1,5-2,1	1,5-3	> 1 x 10^{10}
ORP10	D	293	6	1,1-7,5	2 x 10^{8}
ORP13	D	77	5,3	1-5,5	55 x 10^{9}

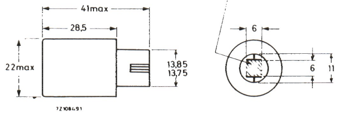
dimensions in mm

61SV
cooled
version;
order no.:
9330 401 30 . . 0



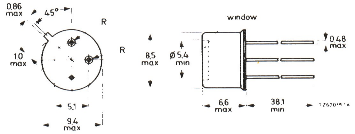
17
8
11,3
flexible leads
75 long
17,5
10
glass dewar with
glass window
6
6
sensitive
area

encapsulated
version;
order no.:
9332 200 30 . . 0

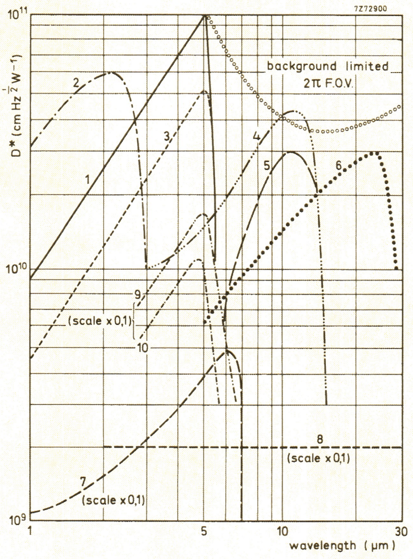


41max
28,5
22max
13,85
13,75
6
6
11
7Z10849

RPY76A
in TO-5
(except
for window)



0,86
max
45°
R
10
max
R
8,5
max
Ø5,4
min
5,1
9,4
max
window
0,48
max
6,6
max
38,1
min



Spectral response of infrared devices.

1. InSb 77 K, 60° FOV
2. PbS 300 K, 2π FOV
3. InSb 77 K, 2π FOV
4. Cd Hg Te 77 K, 60° FOV
5. Ge: Hg 35 K, 60° FOV
6. Ge: Cu 4,2 K, 60° FOV
7. ** InSb 300 K, 2π FOV
8. ** TGS bolometer
9. ** Cd Hg Te 80 °C
10. ** Cd Hg Te 295 K

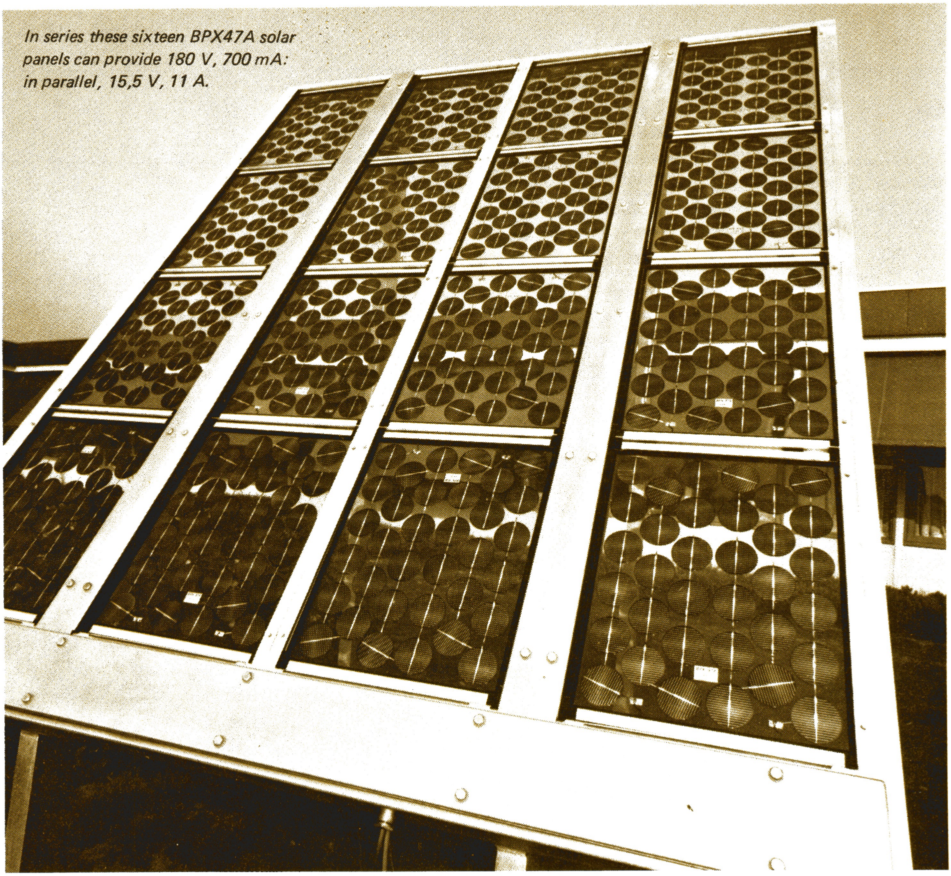
** Scale x 0,1

solar cells

Although solar cells are known for their exacting role in space research, there are many other less publicized activities in which they meet equally demanding needs. Recent concern over the energy situation has focused much attention on solar cells. Solar energy conversion is a fruitful area of development and solar panels will play a major role in the field of energy resources. With other energy sources increasing rapidly in price, solar cells have become a truly economic alternative. And they have no adverse effect on the environment. It is a field in which we have considerable development and manufacturing experience, for space and terrestrial applications. That specialist knowledge on panels and applications is at your service.

For terrestrial use (irradiance from the sun at sea level $E_e = 1\ kW/m^2$)

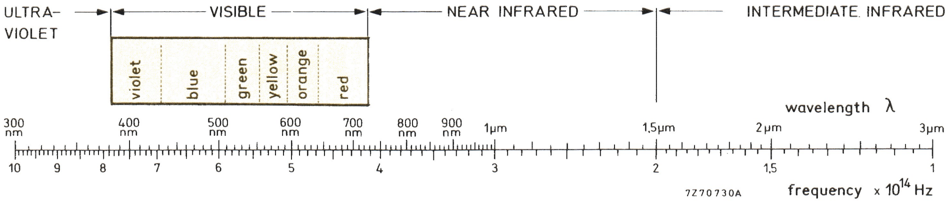
	type	status	dimensions	output at $E_e = 1\ kW/m^2$; $T_{amb} = 25\ ^\circ C$		
				$V_{(opt)}$	I_{opt}	P_{opt}
			mm	V	mA	W
single cell	**BPX46A**	D	ϕ 57	0,455	675	0,31
panel (34 cells)	**BPX47A**	D	468 x 365 x 15	15,5	700	11



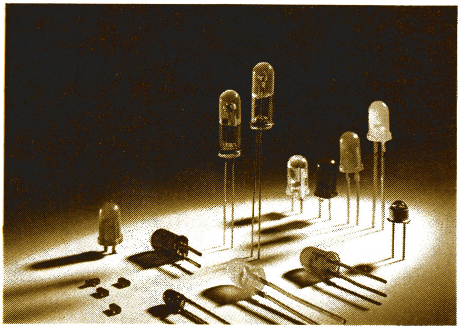
In series these sixteen BPX47A solar panels can provide 180 V, 700 mA: in parallel, 15,5 V, 11 A.

light emitting diodes

LEDs combine the advantages of semiconductors (long life, reliability, etc.) with the high brightness of incandescent lamps. There is a huge increase in applications of LEDs in the consumer field – in tv channel indicators, bar graph arrays for level indications, etc.

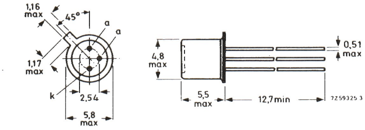

ULTRA-VIOLET
VISIBLE
NEAR INFRARED
INTERMEDIATE INFRARED
violet
blue
green
yellow
orange
red
wavelength λ
300 nm
400 nm
500 nm
600 nm
700 nm
800 nm
900 nm
1μm
1,5μm
2μm
3μm
10
9
8
7
6
5
4
3
2
1,5
1
7Z70730A
frequency x 10^{14} Hz

		RATINGS			CHARACTERISTICS				
type	status	I_F mA	V_R V	P_{tot} mW	ϕ_e min μW	I_e min μW/sr	I_v at typ mcd	I_F mA	α 50% typ deg.
infrared									
CQY11B	D	30	2	50	60	typ 64	–	20	72
CQY11C	D	30	2	50	typ 50	typ 1250	–	20	7
CQY49B	D	100	2	150	–	300	–	50	80
CQY49C	D	100	2	150	–	3000	–	50	15
CQY50	D	100	2	150	160	180	–	20	35
CQY52	D	100	2	150	400	450	–	20	35
CQY58	D	50	2	75	typ 500	400	–	20	10
CQY89	D	130	5	215	5000	7000	–	130	30
red									
CQY24A	D	50	3	100	–	–	> 0,3	20	70
CQY24A I							0,5-1,8		
II							1 -3		
III							> 1,6		
CQY46							0,8		100
CQY47	D	50	3	100	–	–	0,8	20	100
CQY61B							1,5		70
CQY54	D	50	3	100	–	–	> 0,3	20	80
CQY54 I							0,7-1,6		
II							1 -2,2		
III							> 1,6		
CQY88	D	10	3	20	–	–	> 0,3	5	50
green									
CQY94	D	20	3	60	–	–	> 0,3	10	60
CQY95	D	20	3	60	–	–	> 0,3	10	60
yellow									
CQY96	N	20	3	60	–	–	> 0,5	10	60
CQY97	N	20	3	60	–	–	> 0,3	10	60

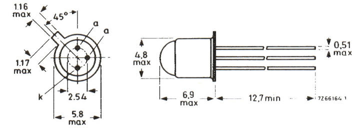


dimensions in mm

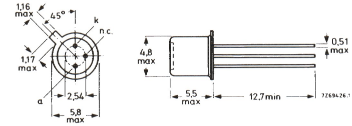
CQY11B in TO-18 (except for window)


1,16
max
45°
a
a
1,17
max
k
2,54
5,8
max
4,8
max
0,51
max
5,5
max
12,7 min
7Z59325.3

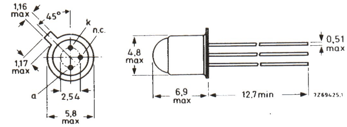
CQY11C in TO-18 (except for lens)


1,16
max
45°
a
a
1,17
max
k
2,54
5,8
max
4,8
max
0,51
max
6,9
max
12,7 min
7Z66164.1

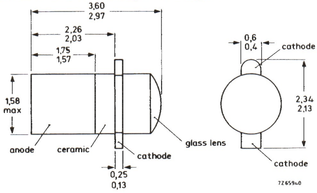
CQY49B in TO-18 (except for window)


1,16
max
45°
k
n.c.
1,17
max
a
2,54
5,8
max
4,8
max
0,51
max
5,5
max
12,7 min
7Z69426.1

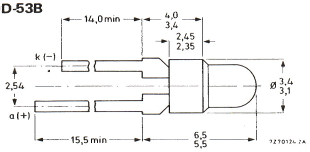
CQY49C in TO-18 (except for lens)


1,16
max
45°
k
n.c.
1,17
max
a
2,54
5,8
max
4,8
max
0,51
max
6,9
max
12,7 min
7Z69425.1

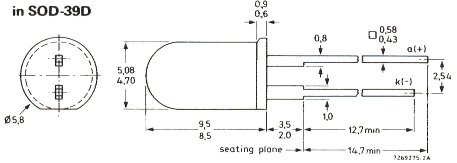
CQY50 and 52 in DO-31 (except for length)


3,60
2,97
2,26
2,03
1,75
1,57
1,58
max
anode
ceramic
cathode
0,25
0,13
glass lens
0,6
0,4
cathode
2,34
2,13
cathode
7Z65940

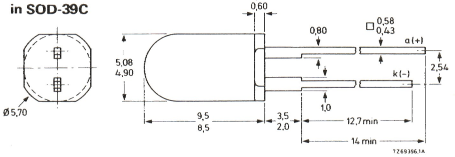
CQY58 in SOD-53B


14,0 min
4,0
3,4
2,45
2,35
k (−)
2,54
a (+)
Ø 3,4
3,1
15,5 min
6,5
5,5
7Z70124.2A

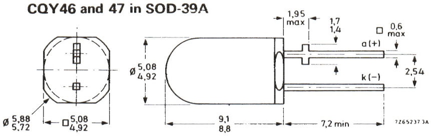
CQY89, 94 and 96
in SOD-39D


0,9
0,6
0,8
□ 0,58
0,43
a (+)
5,08
4,70
k (−)
2,54
Ø5,8
1,0
9,5
8,5
3,5
2,0
12,7 min
seating plane
14,7 min
7Z69275.2A

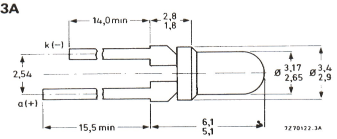
CQY24A, 61B
in SOD-39C


0,90
0,60
0,80
□ 0,58
0,43
a (+)
5,08
4,90
k (−)
2,54
Ø5,70
1,0
9,5
8,5
3,5
2,0
12,7 min
14 min
7Z69396.1A

CQY46 and 47 in SOD-39A


1,95
max
1,7
1,4
□ 0,6
max
a (+)
Ø 5,08
4,92
k (−)
2,54
Ø 5,88
5,72
□ 5,08
4,92
9,1
8,8
7,2 min
7Z65237.3A

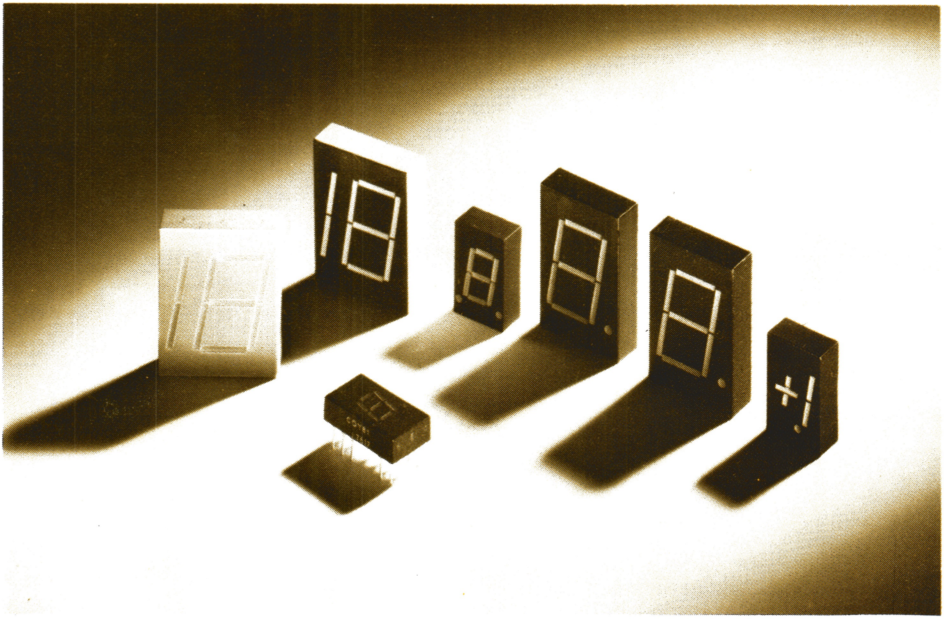
CQY54, 88, 95 and 97
in SOD-53A


14,0 min
2,8
1,8
k (−)
2,54
a (+)
Ø 3,17
2,65
Ø 3,4
2,9
15,5 min
6,1
5,1
7Z70122.3A

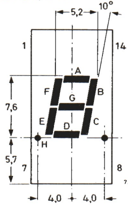
displays

Segment read-out displays with common anode

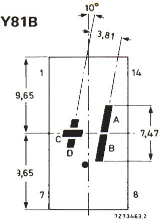
type		status	size of character	RATINGS			CHARACTERISTICS		
			mm	I_F mA	V_R V	P_{tot} mW	I_v mcd	at I_F mA	α 50% typ
red									
CQY81	left hand decimal point	D	7,6 x 5,2	30	3	400	0,25	20	90°
CQY81A	right hand decimal point	D							
CQY81B	polarity and overflow display	N							
CQY82	left hand decimal point	N	11 x 7	30	3	400	0,25	20	90°
CQY82A	right hand decimal point								
CQY82B	polarity and overflow display								
CQY84		D	19,6 x 12	25	3	400	0,25	20	90°
CQX85	with red surface	N	19,6 x 12	30	3	400	0,5	20	90°
CQX85A	with black surface								



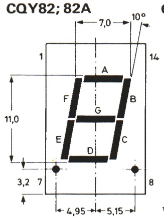
CQY81; 81A


5,2
10°
1
14
A
F
G
B
7,6
E
D
C
H
5,7
7
8
4,0
4,0
7Z70272.5A

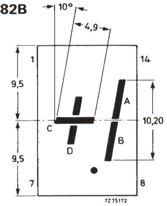
CQY81B


10°
3,81
1
14
9,65
A
C
7,47
D
B
3,65
7
8
7Z73463.2

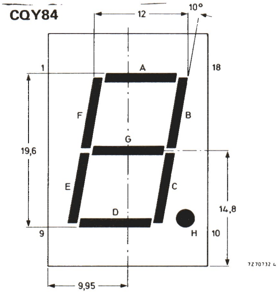
CQY82; 82A


7,0
10°
1
14
A
F
B
11,0
G
E
C
D
3,2
7
8
4,95
5,15
7Z75173

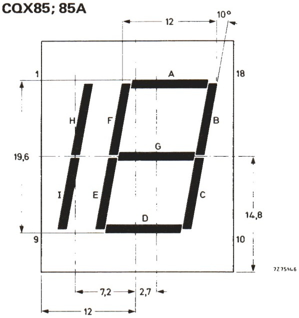
CQY82B


10°
4,9
1
14
9,5
A
10,20
C
B
D
9,5
7
8
7Z75172

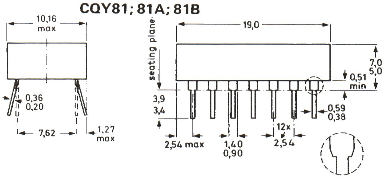
CQY84


12
10°
1
A
18
F
B
19,6
G
E
C
D
14,8
9
H
10
9,95
7Z70732.4

CQX85; 85A


12
10°
1
A
18
H
F
B
19,6
G
I
E
C
D
14,8
9
10
7,2
2,7
12
7Z75146

CQY81; 81A; 81B


10,16 max
seating plane
19,0
7,0
5,0
0,51 min
0,36
0,20
3,9
3,4
0,59
0,38
7,62
1,27 max
12x
2,54 max
1,40
0,90
2,54

CQY81; 81A; 82; 82A

no pins: 4, 5, 9, 12

common anode

pins: 3, 14

cathode pins:

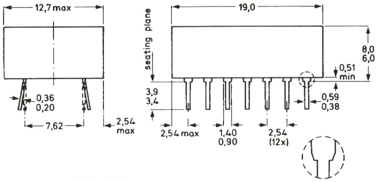
A = 1 E = 7

B = 13 F = 2

C = 10 G = 11

D = 8 H = 6

CQY82; 82A; 82B


12,7 max
seating plane
19,0
8,0
6,0
0,51 min
0,36
0,20
3,9
3,4
0,59
0,38
7,62
2,54 max
2,54 max
1,40
0,90
2,54
(12x)

CQY81B; CQY82B

no pins: 2, 3, 5, 6

12, 13

common anode

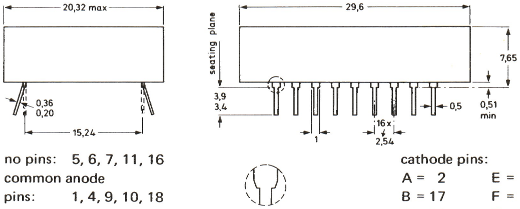
pins: 1, 14

cathode pins:

A = 11 D = 4, 7

B = 10 d.p. = 9

CQY84


20,32 max
seating plane
29,6
7,65
0,36
0,20
3,9
3,4
0,5
0,51 min
15,24
16x
1
2,54

no pins: 5, 6, 7, 11, 16

common anode

pins: 1, 4, 9, 10, 18

cathode pins:

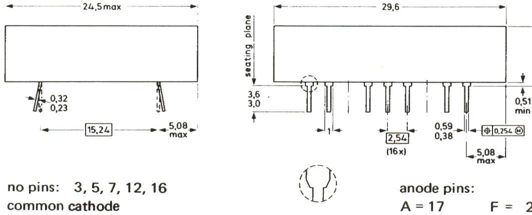
A = 2 E = 8

B = 17 F = 3

C = 14 G = 15

D = 10 H = 12

CQX85; 85A


24,5max
seating plane
29,6
7,6
0,32
0,23
3,6
3,0
0,51 min
15,24
5,08 max
1
2,54
(16x)
0,59
0,38
0,254
5,08 max

no pins: 3, 5, 7, 12, 16

common cathode

pins: 1, 9, 10, 18

anode pins:

A = 17 F = 2

B = 15 G = 14

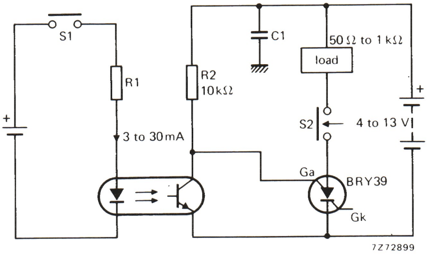
C = 13 H = 4

D = 11 I = 6

E = 8

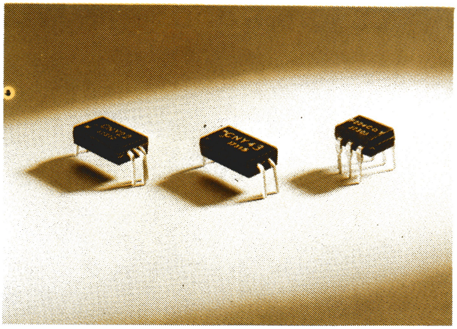
photocouplers

Photocouplers offer the isolator/transfer characteristics prevously confined to relays, transformers, etc. but in a completely solid-state form and with all the advantages such as compactness, compatibility, long life and reliability. They are widely used in telephony and for input/output isolation in computer peripherals and subscriber telephones. They are also ideal in over-current sensor circuits, motor control (a.c. and d.c.), analogue circuits for multiplexing, or as isolators between equipments where one chassis is earthed and the other live or floating (tv set and videorecorder, for example).



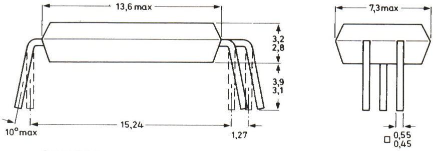
Triggering an SCS via a photocoupler.

		RATINGS						CHARACTERISTICS		
		diode			transistor			photocoupler		
type	status	I_F mA	V_R V	P_{tot} mW	V_{CEO} V	I_C mA	P_{tot} mW	I_C/I_F min %	V_{CEsat} max V	isolation test voltage (r.m.s.) V
CNY22	D	30	2	50	50	30	200	25	0,4	2800
CNY42	D	30	2	50	50	30	200	25	0,4	2800
CNY23	D	30	2	50	30	30	200	50	0,4	2000
CNY43	D	30	2	50	30	30	200	50	0,4	2000
CNY44	D	30	3	50	50	30	80	30	0,4	1000
CNY46	as CNY44 but differs in pinning									
CNY47	D	30	3	100	30	30	150	20	0,4	2000
CNY47A	D	30	3	100	30	30	150	40	0,4	2000
CNY48	D	60	3	100	30	100	150	600	1	1500



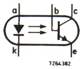
Encapsulations used for our range of photocouplers.

dimensions in mm



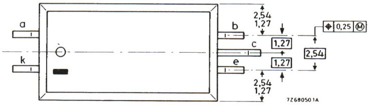
13,6 max
3,2
2,8
3,9
3,1
15,24
1,27
10° max
7,3max
0,55
0,45

CNY22
CNY23



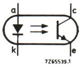
a
b
c
k
e
7Z64382

SOT-91A



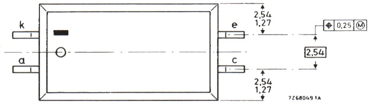
a
k
b
c
e
2,54
1,27
1,27
1,27
2,54
0,25 M
2,54
1,27
7Z68050.1A

CNY42
CNY43



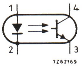
a
c
k
e
7Z65539.1

SOT-91B



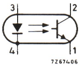
k
a
e
c
2,54
1,27
0,25 M
2,54
2,54
1,27
7Z68049.1A

CNY44



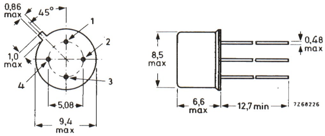
1
4
2
3
7Z62169

CNY46



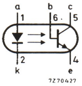
3
2
4
1
7Z67406

TO-12



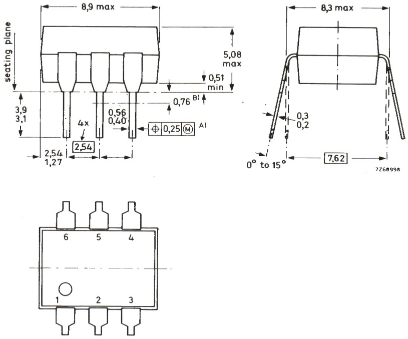
0,86 max
45°
1
2
1,0 max
4
3
5,08
9,4 max
8,5 max
0,48 max
6,6 max
12,7 min
7Z68226

CNY47 and 47A



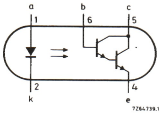
a
b
c
1
6
5
2
4
k
e
7Z70427

SOT-90



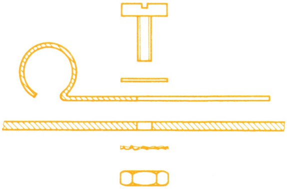
8,9 max
seating plane
5,08 max
0,51 min
0,76 B)
3,9
3,1
4x
0,56
0,40
0,25 M A)
2,54
2,54
1,27
8,3 max
0,3
0,2
0° to 15°
7,62
7Z68998
6
5
4
1
2
3

CNY48



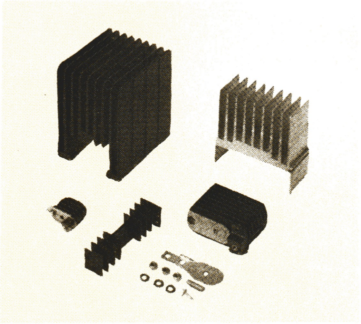
a
b
c
1
6
5
2
4
k
e
7Z64739.1

accessories and heatsinks



Accessories

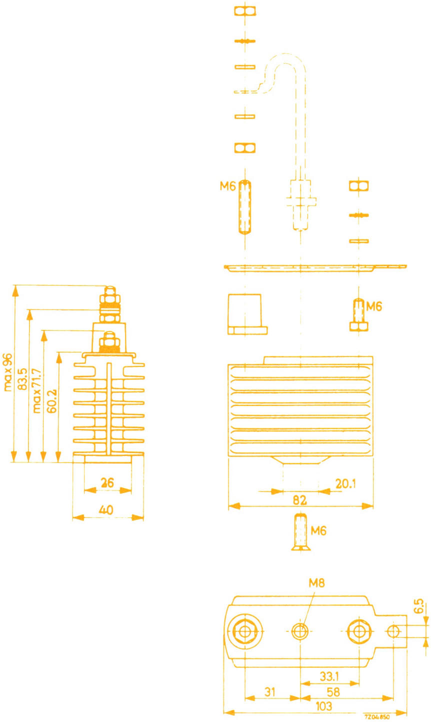
type no	description	application	detailed description
56200	Cooling fin	TO-1	
56201	Mounting accessories	TO-3	1 mica washer 2 insulating bushes 2 cheese-head screws (M3) 3 plain metal washers 1 soldering tag 2 lock washers 2 hexagon nuts (M3)
56201c; 01j	2 insulating bushes (height 4,5 mm; 01j height 5 mm)	TO-3	
56201d	Mica washer of 56201	TO-3	
56203	Mica washer; 2 insulating bushes	TO-3	
56218	Mounting accessories	TO-5; TO-39	1 top clamping piece 1 bottom clamping piece 1 mylar insulator
56233	Mounting strip	Heatsinks	
56234	Mounting strip	Heatsinks	
56245	Distance disc of insulating material	TO-5; TO-39	
56246	Distance disc of insulating material	TO-18; TO-72	
56261; 61a	2 insulating bushes (height 6 mm; 61a height 6,5 mm)	TO-3	
56262A	Mica washer; insulating ring; plain washer	DO-4; TO-64	
56263	Cooling fin	TO-18; TO-72	
56264A	Mica washer; insulating ring; soldering tag	DO-4; DO-5; TO-48	
56295	PTFE bush; 2 mica washers; plain washer; soldering tag	DO-4; TO-64	
56299	Insulating ring of 56264A	DO-4; DO-5; TO-48	
56309B	External lead (blue)	DO-5	
56309R	External lead (red)	DO-5	
56316	Mica washer	SOD-38	
56326	Metal washer	TO-126(SOT-32)	
56333	Metal washer; mica washer; insulating bush	TO-126(SOT-32)	
56337	Mica washer; 2 insulating bushes	TO-66	
56339	Mica washer	TO-3	
56351	Mounting accessories	TO-3	1 mica washer 1 mounting support 2 cheese-head screws (M3) 3 plain metal washers 1 soldering tag 2 lock washers 2 hexagon nuts (M3)
56352	Mounting support	TO-3	
56353	Clip	SOT-32; SOT-82	
56354	Mica insulator	SOT-32; SOT-82	
56356	Cooling clip	TO-92 variant	
56359	Mica insulator; insulating bush	TO-220	
56360	Mounting accessories	TO-220	1 cheese-head screw (M3) 1 hexagonal nut (M3) 1 rectangular washer 1 plain washer 1 lock washer
56363	Clip	TO-220	
56364	Clip; to be used in conjunction with 56367 or 56369	TO-220	
56367	Alumina insulators, to be used in conjunction with 56364	TO-220	
56368	Mica insulator; insulating bush	SOT-93	
56369	Mica insulator, to be used with 56364	TO-220	



Heatsinks

type no	
56230	HE
56231	HE
56253	DH
56256	DH
56268	DH
56271	DH
56278	DH
56280	DH
56290	HE
56293	HE
56312	DH
56313	DH
56314	DH
56315	DH
56318	DH
56319	DH
56334	DH
56348	DH
56349	DH
56350	DH

DH = Diecast heatsink
HE = Heatsink extrusion


M6
M6
max 96
83.5
max 71.7
60.2
26
40
20.1
82
M6
M8
6.5
33.1
58
31
103
7Z04850

for quick selection please refer
to the selection guide
on pages A84 - A85

heatsinks

selection guide

Rectifier diodes
Thyristors
Triacs

K-code to DIN-41882	K15	K9	K9	K5	K5	K3	K3	K3	K3	K3
type	**56268**	**56256**	**56350**	**56334**	**56349**	**56319**	**56253**	**56312**	**56271**	**56348**
BYX38	●									
BYX39	●	●								
BYX50	●									
1N3880/81/82	●									
1N3890/91/92	●	●		●						
BYX98	●	●								
BYX42	●	●		●						
BYX99		●		●						
BYX30		●		●						
BYX25		●		●		●				
BYX46		●		●		●				
BYW30		●	●	●	●					
BYW31			●	●	●	●				●
BYX96										●
BYW92							●	●		
BYX56							●			
BYX97								●		
BYX32										
BYX52							●			
BTY79	●	●		●		●				
BTW38	●		●		●					●
BTW42			●		●					●
BTY87							●			
BTY91							●			
BTW47								●		
BTW30								●		
BTW45								●		
BTW40								●		
BTW92								●		
BTW31								●		
BTW24										
BTW33										
BTW23										
BTW43			●		●					
BTX94							●			
BTW34										

K-code to DIN-41882	K1,1	K1,1	K1,1	K1,1	K0,55	K0,55	Extrusions			
type	**56278**	**56313**	**56314**	**56280**	**56318**	**56315**	**56230**	**56231**	**56290**	**56293**
BYX38							●		●	
BYX39							●		●	
BYX50							●		●	
1N3880/81/82							●		●	
1N3890/91/92							●	●	●	
BYX98							●	●	●	
BYX42							●	●	●	
BYX99							●	●	●	
BYX30							●	●	●	
BYX25							●	●	●	
BYX46							●	●	●	
BYW30										
BYW31										
BYX96							●	●		●
BYW92	●	●					●	●		●
BYX56	●						●	●		●
BYX97		●					●	●		●
BYX32				●		●				●
BYX52	●						●	●		●
BTY79									●	
BTW38									●	
BTW42									●	
BTY87	●						●	●	●	
BTY91	●						●	●	●	
BTW47		●					●	●	●	
BTW30		●					●	●	●	
BTW45		●					●	●	●	
BTW40		●					●	●	●	
BTW92		●					●	●	●	
BTW31		●					●	●	●	
BTW24			●		●		●	●		●
BTW33				●		●				●
BTW23				●		●				●
BTW43									●	
BTX94	●						●	●	●	
BTW34			●		●		●	●		●

successor types

The list of successor types is specially included to guide your future new design or re-design plans. It has little use when seeking direct replacement types. For that purpose use our separate book Replacement guide for Semiconductors.

Successors of current types

current type	successor
BAX12	BAX12A
BAX14	BAX14A
BAX18	BAX18A
BB105G	BB205G
BB110B	BB204B
BB110G	BB204G
BC147 to 149	BC547 to 549
BC157 to 159	BC557 to 559
BF194	BF494
BF195	BF495
BF196	BF198
BF197	BF199
BFS21	BFQ15
BFS21A	BFQ14
BFS28	BFR84

current type	successor
BTW47*	BTW45*
BTY79	BTW38
BTY87	BTW38; BTW45
BTY91	BTW45
BY209	BY409
BYX25*	BYX96*
BYX30-200(R)	1N3891(R)
BYX30-300(R)	1N3892(R)
BYX56*	BYX97*
BZY95*	BZX70*
BZZ20 to 29	BZV15*
2N929	BCY58; BCY59
2N930	BCY58; BCY59
2N2368	BSX19
2N2369	BSX20
2N2369A	BSX20

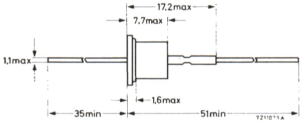
Successors of maintenance types

maintenance type	successor
AAY21	AAZ18
AAY30	AAZ17; AAZ18
AAY32	AAZ17; AAZ18
AAZ13	AAZ18
AC127/01	AC187/01; BC368
ASY26	2N2894(A)
ASY27	2N2894(A)
ASY28	BSX19; BSX20
ASY29	BSX19; BSX20
ASZ15 to 18	BDX92; BDX94; BDX96
BB105A	BB205A
BCY55	BCY87
BDY93	BUX82
BDY94	BUX82
BDY96	BUX80
BDY97	BUX80

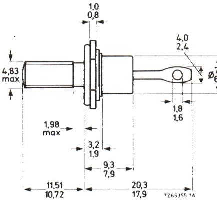
maintenance type	successor
BF167	BF198
BF177	BF336
BF178	BF336
BF179	BF337
BFX44	BSX20
2N1302	BSX19; BSX20
2N1303	2N2894(A)
2N1304	BSX19; BSX20
2N1305	2N2894(A)
2N1306	BSX19; BSX20
2N1307	2N2894(A)
2N1308	BSX19; BSX20
2N1309	2N2894(A)

cases

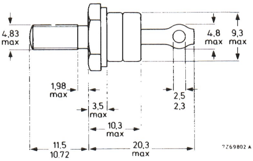
DO-1


17,2max
7,7max
1,1max
1,6max
35min
51min
7Z11073 A

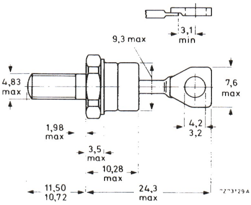
DO-4(1) 10-32 UNF or M5


1,0
0,8
4,0
2,4
4,83
max
Ø7,1
6,8
1,8
1,6
1,98
max
3,2
1,9
9,3
7,9
11,51
10,72
20,3
17,9
7Z65355 A

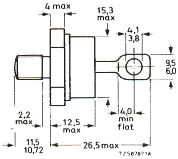
DO-4(2) 10-32 UNF or M5


4,83
max
4,8
max
9,3
max
1,98
max
3,5
max
2,5
2,3
10,3
max
11,5
10,72
20,3
max
7Z69802 A

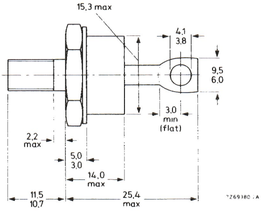
DO-4(3) 10-32 UNF or M5


3,1
min
9,3 max
4,83
max
7,6
max
1,98
max
4,2
3,2
3,5
max
10,28
max
11,50
10,72
24,3
max

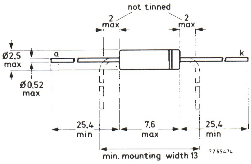
DO-5(1) ¼" x 28 UNF or M6


4 max
15,3
max
4,1
3,8
9,5
6,0
2,2
max
12,5
max
4,0
min
flat
11,5
10,72
26,5max
7Z58787 A

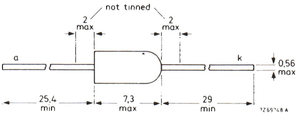
DO-5(2) ¼" x 28 UNF or M6


15,3 max
4,1
3,8
9,5
6,0
3,0
min
(flat)
2,2
max
5,0
3,0
14,0
max
11,5
10,7
25,4
max
7Z69380 A

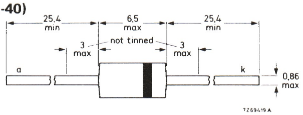
DO-7


not tinned
2
max
2
max
Ø2,5
max
a
k
Ø0,52
max
25,4
min
7,6
max
25,4
min
min. mounting width 13
7Z65474

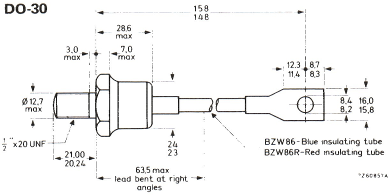
DO-14


not tinned
2
max
2
max
a
k
0,56
max
25,4
min
7,3
max
29
min
7Z69748 A

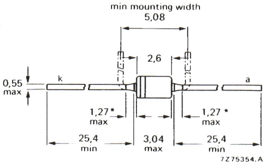
DO-15 (SOD-40)


25,4
min
6,5
max
25,4
min
3
max
not tinned
3
max
a
k
0,86
max
7Z69419 A

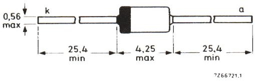
DO-30


158
148
28,6
max
3,0
max
7,0
max
12,3
11,4
8,7
8,3
Ø12,7
max
8,4
8,2
16,0
15,8
½"x20 UNF
21,00
20,24
24
23
BZW86-Blue insulating tube
BZW86R-Red insulating tube
63,5 max
lead bent at right
angles
7Z60857A

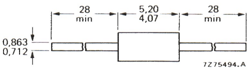
DO-34


min mounting width
5,08
2,6
0,55
max
k
a
1,27*
max
1,27*
max
25,4
min
3,04
max
25,4
min
7Z75354.A

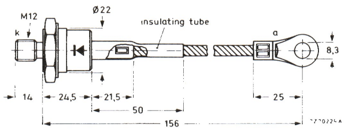
DO-35


0,56
max
k
a
25,4
min
4,25
max
25,4
min
7Z66721.1

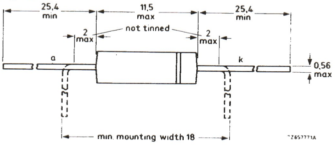
DO-41


28
min
5,20
4,07
28
min
0,863
0,712
7Z75494.A

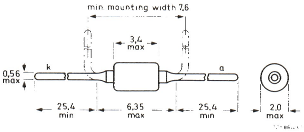
SOD-8


M12
Ø22
insulating tube
k
a
8,3
14
24,5
21,5
50
25
156
7Z70224A

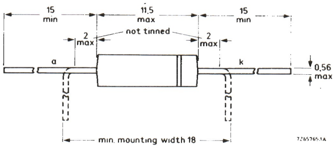
SOD-34(1) long leads


25,4 min
11,5 max
25,4 min
2 max
not tinned
2 max
a
k
0,56 max
min. mounting width 18
7Z65777.1A

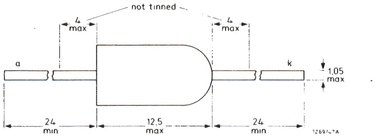
SOD-17


min. mounting width 7,6
3,4 max
0,56 max
k
a
25,4 min
6,35 max
25,4 min
2,0 max

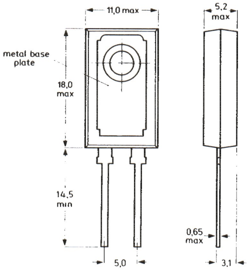
SOD-34(2) medium leads


15 min
11,5 max
15 min
2 max
not tinned
2 max
a
k
0,56 max
min. mounting width 18
7Z65765.1A

SOD-18


not tinned
4 max
4 max
a
k
1,05 max
24 min
12,5 max
24 min

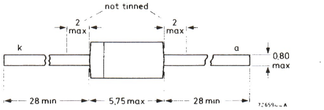
SOD-38


11,0 max
5,2 max
metal base plate
18,0 max
14,5 min
0,65 max
5,0
3,1
7Z60001.5A

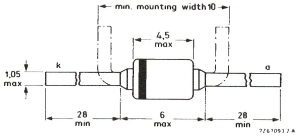
tag 2 tag 1

For polarity consider tag 1 = base-plate as mounting base.

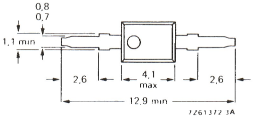
SOD-22


not tinned
2 max
2 max
k
a
0,80 max
28 min
5,75 max
28 min

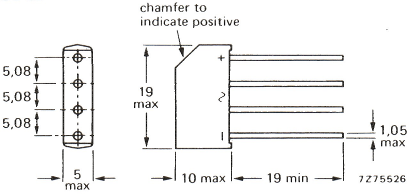
SOD-51


min. mounting width 10
4,5 max
1,05 max
k
a
28 min
6 max
28 min
7Z67093.2A

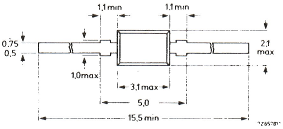
SOD-23


0,8
0,7
1,1 min
2,6
4,1 max
2,6
12,9 min
7Z61372.3A

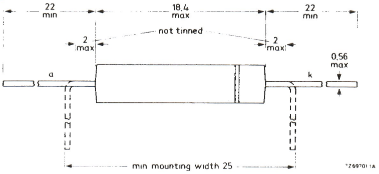
SOD-28


chamfer to indicate positive
5,08
5,08
5,08
+
~
-
19 max
1,05 max
5 max
10 max
19 min
7Z75526

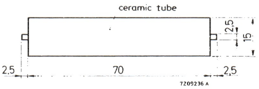
SOD-52


1,1 min
1,1 min
0,75
0,5
2,1 max
1,0 max
3,1 max
5,0
15,5 min

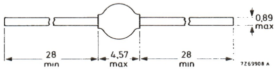
SOD-56


22 min
18,4 max
22 min
not tinned
2 max
2 max
0,56 max
a
k
min. mounting width 25
7Z69701.1A

SOD-29

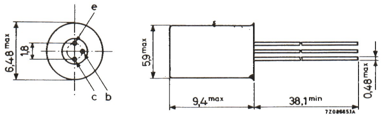

ceramic tube
12,5
15
2,5
70
2,5
7Z09236A

SOD-57


0,89 max
28 min
4,57 max
28 min
7Z69908A

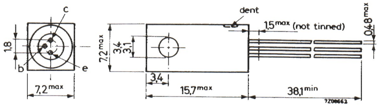
cases

TO-1



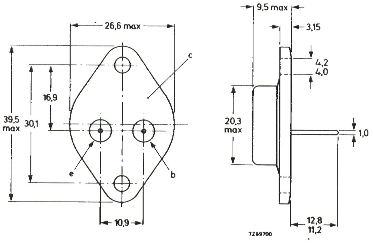
e
c b
6,48 max
1,8
5,9 max
9,4 max
38,1 min
0,48 max
7Z08665.1A

TO-1(1) with heat-conducting block



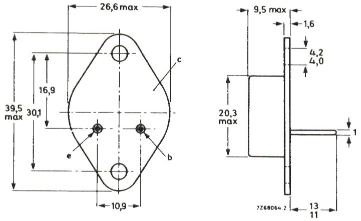
c
1,8
b
e
7,2 max
7,2 max
3,4
3,1
3,4
15,7 max
dent
1,5 max (not tinned)
0,48 max
38,1 min
7Z08662

TO-3(1)



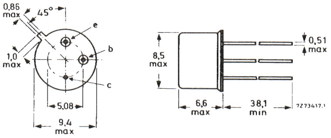
26,6 max
c
16,9
39,5 max
30,1
e
b
10,9
9,5 max
3,15
4,2
4,0
20,3 max
1,0
12,8
11,2
7Z69700

TO-3(2)



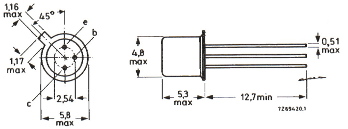
26,6 max
c
16,9
39,5 max
30,1
e
b
10,9
9,5 max
1,6
4,2
4,0
20,3 max
1
7Z68064.2
13
11

TO-5(1) collector to case



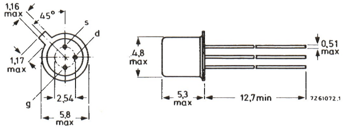
0,86 max
45°
e
b
1,0 max
c
5,08
9,4 max
8,5 max
6,6 max
38,1 min
0,51 max
7Z73417.1

TO-18(1)



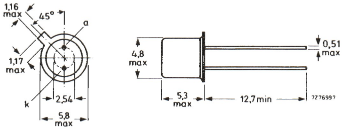
1,16 max
45°
e
b
1,17 max
c
2,54
5,8 max
4,8 max
5,3 max
12,7 min
0,51 max
7Z69420.1

TO-18(2)



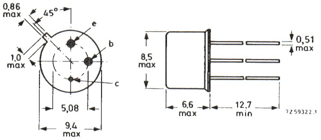
1,16 max
45°
s
d
1,17 max
g
2,54
5,8 max
4,8 max
5,3 max
12,7 min
0,51 max
7Z61072.1

TO-18(3) (2 leads)



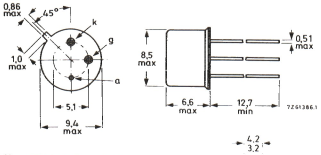
1,16 max
45°
a
1,17 max
k
2,54
5,8 max
4,8 max
5,3 max
12,7 min
0,51 max
7Z76997

TO-39(1)



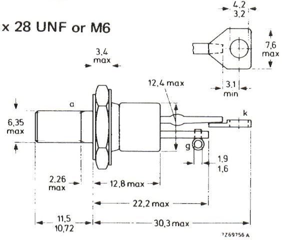
0,86 max
45°
e
b
1,0 max
c
5,08
9,4 max
8,5 max
6,6 max
12,7 min
0,51 max
7Z59322.1

TO-39(2)



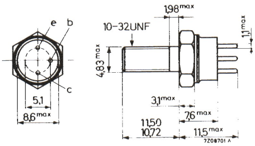
0,86 max
45°
k
g
1,0 max
a
5,1
9,4 max
8,5 max
6,6 max
12,7 min
0,51 max
7Z61386.1

TO-48 ¼" x 28 UNF or M6



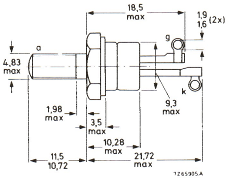
4,2
3,2
7,6 max
3,4 max
3,1 min
12,4 max
a
k
g
6,35 max
1,9
1,6
2,26 max
12,8 max
22,2 max
11,5
10,72
30,3 max
7Z69756 A

TO-60

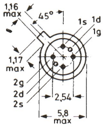


e b
c
5,1
8,6 max
1,98 max
10-32UNF
1,1 max
4,83 max
3,1 max
7,6 max
11,50
10,72
11,5 max
7Z08701 A

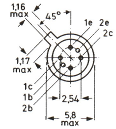
TO-64 10-32 UNF or M5

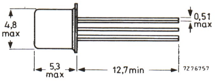

18,5
max
1,9
1,6 (2x)
a
g
4,83
max
k
9,3
max
1,98
max
3,5
max
10,28
max
11,5
10,72
21,72
max
7Z65905A

TO-71(1)

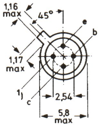

1,16
max
45°
1s
1d
1g
1,17
max
2g
2d
2s
2,54
5,8
max

TO-71(2)

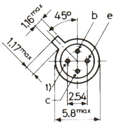

1,16
max
45°
1e
2e
2c
1,17
max
1c
1b
2b
2,54
5,8
max


4,8
max
0,51
max
5,3
max
12,7min
7Z76757

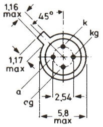
TO-72(1)


1,16
max
45°
e
b
1,17
max
1)
c
2,54
5,8
max

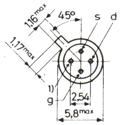
TO-72(2)

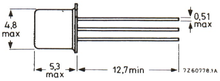

1,16max
45°
b
e
1,17max
1)
c
2,54
5,8max

TO-72(3)


1,16
max
45°
k
kg
1,17
max
a
cg
2,54
5,8
max

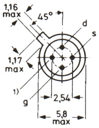
TO-72(4)


1,16max
45°
s
d
1,17max
1)
g
2,54
5,8max

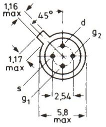

4,8
max
0,51
max
5,3
max
12,7min
7Z60778.1A

1) = shield lead (connected to case)

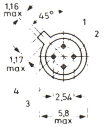
TO-72(5)

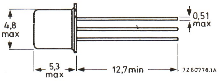

1,16
max
45°
d
s
1,17
max
1)
g
2,54
5,8
max

TO-72(6)

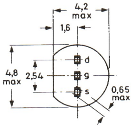

1,16
max
45°
d
g2
1,17
max
s
g1
2,54
5,8
max

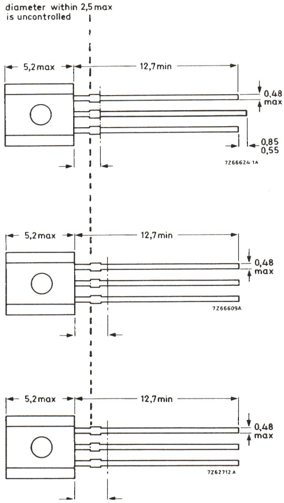
TO-72(7)


1,16
max
45°
1
2
1,17
max
4
3
2,54
5,8
max


4,8
max
0,51
max
5,3
max
12,7min
7Z60778.1A

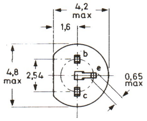
TO-92


4,2
max
1,6
d
g
s
4,8
max
2,54
0,65
max

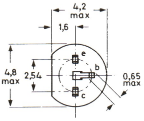

diameter within 2,5 max
is uncontrolled
5,2max
12,7min
0,48
max
0,85
0,55
7Z66624.1A
5,2max
12,7min
0,48
max
7Z66609A
5,2max
12,7min
0,48
max
7Z62712A

TO-92 variants

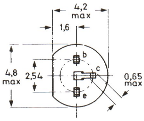
TO-92(1)


4,2
max
1,6
b
e
c
4,8
max
2,54
0,65
max

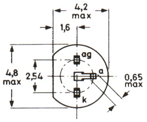
TO-92(2)


4,2
max
1,6
e
b
c
4,8
max
2,54
0,65
max

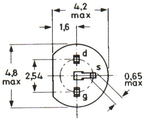
TO-92(3)


4,2
max
1,6
b
c
e
4,8
max
2,54
0,65
max

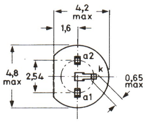
TO-92(4)


4,2
max
1,6
ag
a
k
4,8
max
2,54
0,65
max

TO-92(5)

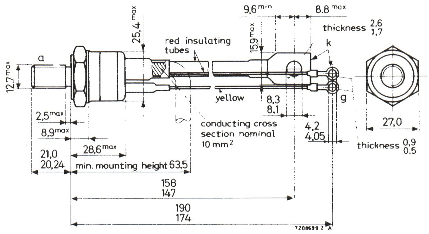

4,2
max
1,6
d
s
g
4,8
max
2,54
0,65
max

TO-92(6)


4,2
max
1,6
a2
k
a1
4,8
max
2,54
0,65
max

cases

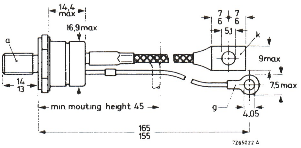
TO-94 ½" x 20 UNF or M12



a
12,7 max
25,4 max
red insulating tubes
15,9 max
9,6 min
8,8 max
thickness 2,6 1,7
k
g
yellow
8,3 8,1
conducting cross section nominal 10 mm²
4,2 4,05
27,0
thickness 0,9 0,5
2,5 max
8,9 max
21,0 20,24
28,6 max
min. mounting height 63,5
158 147
190 174
7Z08699 2 A

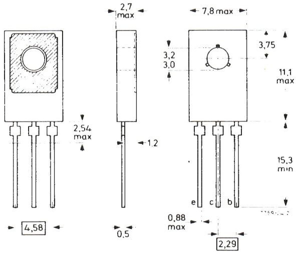
TO-103 $^5/_{16}$ " x 24UNF or M8 x 1,25

triac: k = T_1
a = T_2



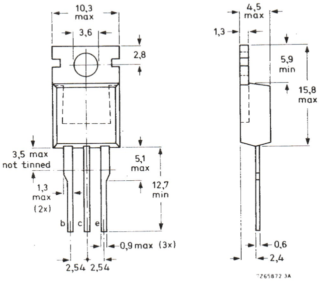
14,4 max
16,9 max
a
7 6
7 6
5,1
k
9max
7,5max
14 13
min.mouting height 45
g
4,05
165 155
7Z65022 A

TO-126



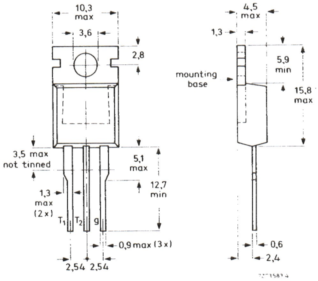
2,7 max
7,8 max
3,2 3,0
3,75
11,1 max
2,54 max
1,2
15,3 min
e
c
b
4,58
0,5
0,88 max
2,29

TO-220(1)



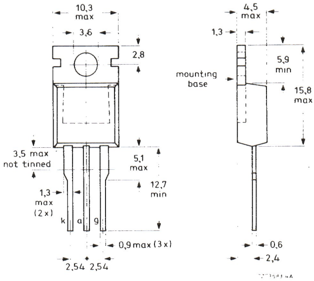
10,3 max
3,6
2,8
4,5 max
1,3
5,9 min
15,8 max
3,5 max not tinned
5,1 max
1,3 max (2x)
12,7 min
b
c
e
0,9 max (3x)
2,54 2,54
0,6
2,4
7Z65872 3A

TO-220AB(2)



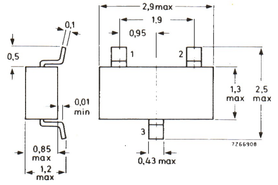
10,3 max
3,6
2,8
4,5 max
1,3
mounting base
5,9 min
15,8 max
3,5 max not tinned
5,1 max
12,7 min
1,3 max (2x)
T1
T2
g
0,9 max (3x)
2,54 2,54
0,6
2,4

TO-220AB(3)

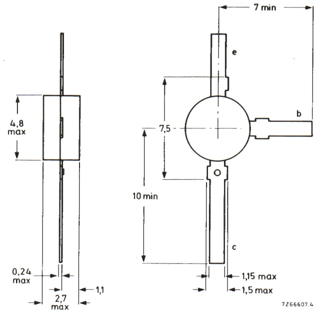


10,3 max
3,6
2,8
4,5 max
1,3
mounting base
5,9 min
15,8 max
3,5 max not tinned
5,1 max
12,7 min
1,3 max (2x)
k
a
g
0,9 max (3x)
2,54 2,54
0,6
2,4

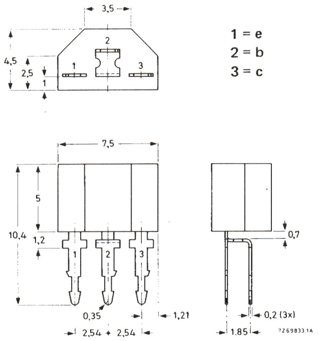
SOT-23


2,9max
1,9
0,95
0,1
0,5
1
2
3
1,3 max
2,5 max
0,01 min
0,85 max
1,2 max
0,43 max
7Z66908

SOT-37(1)

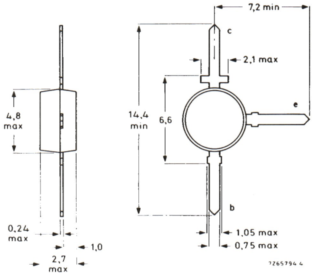

7 min
e
b
4,8 max
7,5
10 min
c
0,24 max
2,7 max
1,1
1,15 max
1,5 max
7Z66607.4

SOT-25(1)

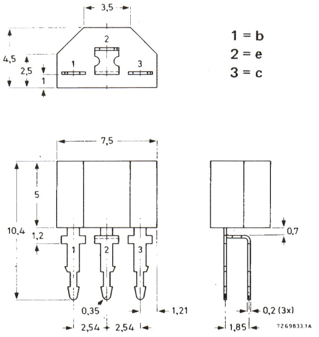

3,5
2
1
3
4,5
2,5
1
7,5
5
10,4
1,2
0,7
0,35
1,21
2,54
2,54
0,2 (3x)
1,85
7Z69833.1A

1 = e
2 = b
3 = c

SOT-37(2)

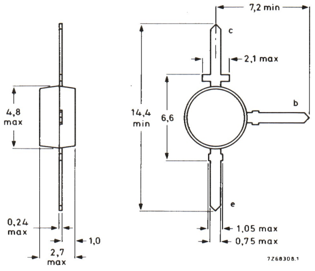

7,2 min
c
2,1 max
e
4,8 max
14,4 min
6,6
b
0,24 max
1,0
2,7 max
1,05 max
0,75 max
7Z65794.4

SOT-25(2)


3,5
2
1
3
4,5
2,5
1
7,5
5
10,4
1,2
0,7
0,35
1,21
2,54
2,54
0,2 (3x)
1,85
7Z69833.1A

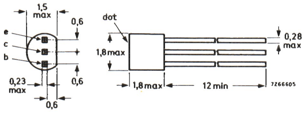
1 = b
2 = e
3 = c

SOT-37(4)


7,2 min
c
2,1 max
b
4,8 max
14,4 min
6,6
e
0,24 max
1,0
2,7 max
1,05 max
0,75 max
7Z68308.1

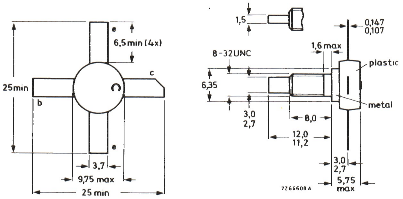
cases

SOT-42



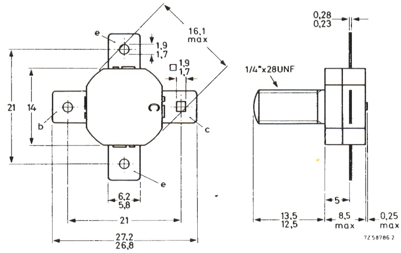
1,5 max
0,6
dot
e
c
b
0,28 max
1,8 max
0,23 max
0,6
0,6
1,8 max
12 min
7Z66605

SOT-48(2)



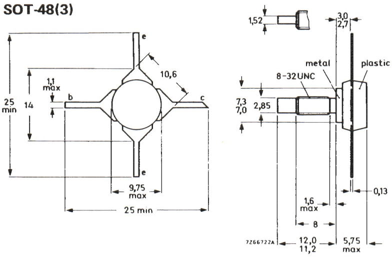
e
6,5 min (4x)
c
25 min
b
e
3,7
9,75 max
25 min
1,5
0,147
0,107
1,6 max
8-32UNC
plastic
6,35
metal
3,0
2,7
8,0
12,0
11,2
3,0
2,7
5,75 max
7Z66608A

SOT-55



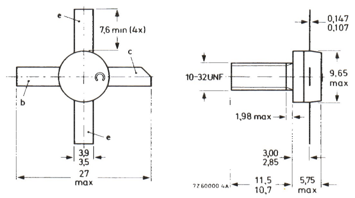
e
16,1 max
1,9
1,7
1,9
1,7
21
14
b
c
e
6,2
5,8
21
27,2
26,8
0,28
0,23
1/4"x28UNF
5
13,5
12,5
8,5 max
0,25 max
7Z58786.2

SOT-48(3)



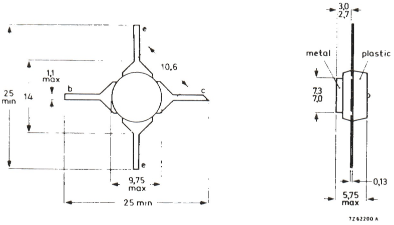
e
10,6
1,1 max
25 min
14
b
c
e
9,75 max
25 min
1,52
3,0
2,7
metal
plastic
8-32UNC
7,3
7,0
2,85
0,13
1,6 max
8
12,0
11,2
5,75 max
7Z66722A

SOT-56



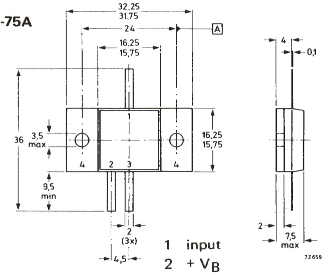
e
7,6 min (4x)
c
b
e
3,9
3,5
27 max
0,147
0,107
10-32UNF
9,65 max
1,98 max
3,00
2,85
11,5
10,7
5,75 max
7Z60000.4A

SOT-48(4)



e
10,6
1,1 max
25 min
14
b
c
e
9,75 max
25 min
3,0
2,7
metal
plastic
7,3
7,0
0,13
5,75 max
7Z62200.A

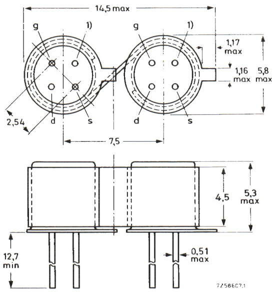
SOT-75A



32,25
31,75
24
A
16,25
15,75
1
36
3,5 max
4
2
3
4
16,25
15,75
9,5 min
2 (3x)
4,5
4
0,1
2
7,5 max
7Z65901.A

1 input
2 + V_B
3 output
4 r.f. and d.c. ground

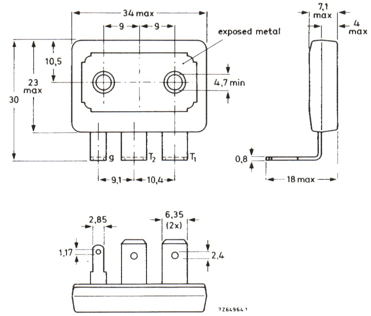
SOT-52



14,5 max
g
1)
g
1)
1,17 max
1,16 max
5,8 max
2,54
d
s
d
s
7,5
4,5
5,3 max
12,7 min
0,51 max
7Z58607.1

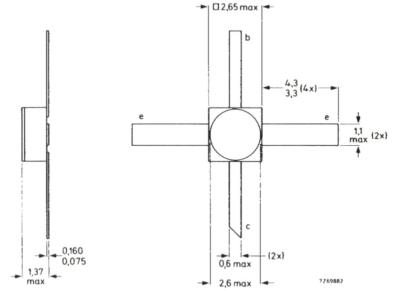
1) = shield lead (connected to case)

SOT-80



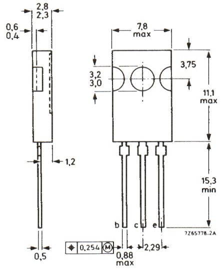
34 max
9
9
exposed metal
10,5
23 max
30
4,7 min
g
T2
T1
9,1
10,4
7,1 max
4 max
0,8
18 max
2,85
6,35 (2x)
1,17
2,4
7Z64964.1

SOT-100



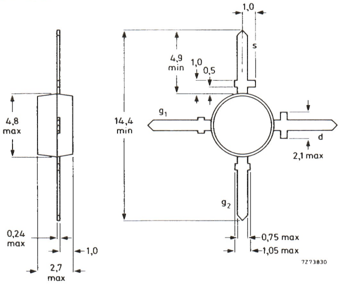
□2,65 max
b
4,3
3,3 (4x)
e
e
1,1 max (2x)
c
0,160
0,075
1,37 max
0,6 max
(2x)
2,6 max
7Z69882

SOT-82



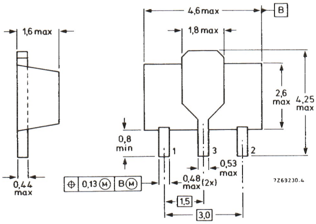
2,8
2,3
0,6
0,4
7,8 max
3,75
3,2
3,0
11,1 max
1,2
15,3 min
b
c
e
7Z65778.2A
0,5
⊕ 0,254 Ⓜ
0,88 max
2,29

SOT-103



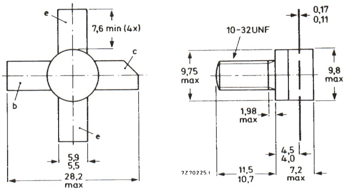
1,0
s
4,9 min
1,0
0,5
4,8 max
14,4 min
g1
d
2,1 max
g2
0,24 max
1,0
2,7 max
0,75 max
1,05 max
7Z73830

SOT-89



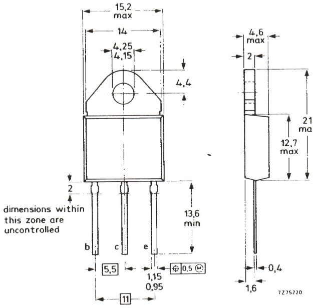
1,6 max
4,6 max
B
1,8 max
2,6 max
4,25 max
0,8 min
1
3
2
0,53 max
0,48 max (2x)
0,44 max
⊕ 0,13 Ⓜ B Ⓜ
1,5
3,0
7Z69230.4

SOT-105



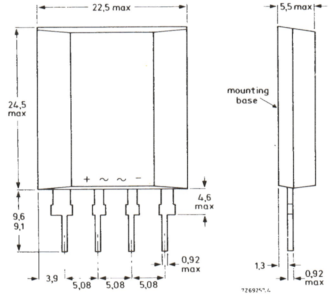
e
7,6 min (4x)
c
b
e
5,9
5,5
28,2 max
0,17
0,11
10-32UNF
9,75 max
9,8 max
1,98 max
4,5
4,0
11,5
10,7
7,2 max
7Z70225.1

SOT-93



15,2 max
14
4,25
4,15
4,4
4,6 max
2
21 max
12,7 max
2
dimensions within this zone are uncontrolled
13,6 min
b
c
e
5,5
1,15
0,95
⊕ 0,5 Ⓜ
11
0,4
1,6
7Z75220

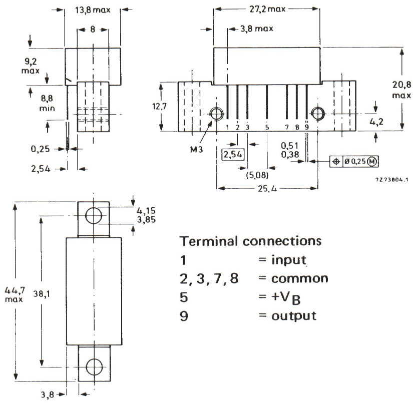
SOT-112



22,5 max
5,5 max
mounting base
24,5 max
+ ~ ~ −
4,6 max
9,6
9,1
0,92 max
3,9
5,08
5,08
5,08
1,3
0,92 max
7Z69252.4

cases

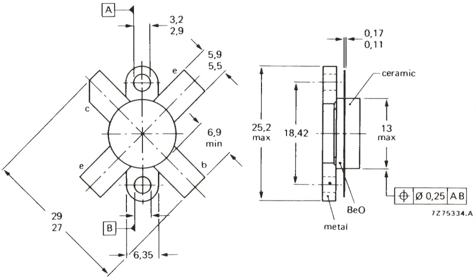
SOT-115


13,8 max
8
27,2 max
3,8 max
9,2 max
8,8 min
20,8 max
12,7
1 2 3 5 7 8 9
4,2
M3
0,25
2,54
0,51
0,38
(5,08)
25,4
0,25 M
2,54
7Z73804.1
4,15
3,85
44,7 max
38,1
3,8

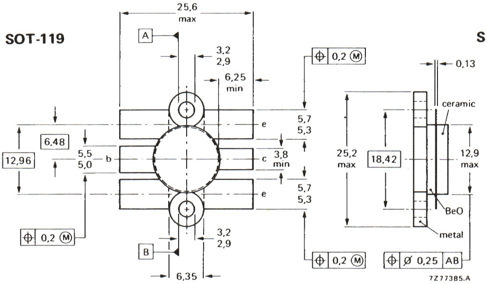
Terminal connections

1	= input
2, 3, 7, 8	= common
5	= $+V_B$
9	= output

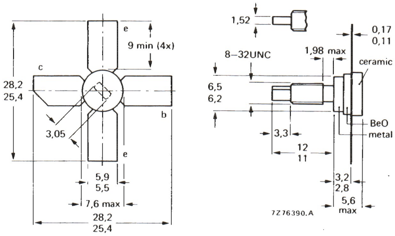
SOT121A


A
3,2
2,9
5,9
5,5
e
c
6,9 min
e
b
29
27
B
6,35
0,17
0,11
ceramic
25,2 max
18,42
13 max
Ø 0,25 AB
BeO
metal
7Z75334.A

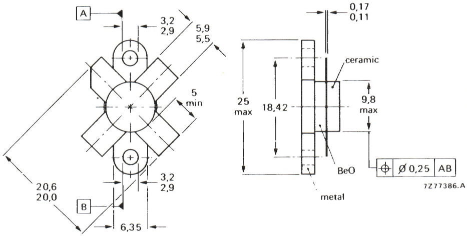
SOT-119


25,6 max
A
3,2
2,9
6,25 min
0,2 M
0,13
ceramic
e
5,7
5,3
6,48
12,96
5,5
5,0
b
c
3,8 min
25,2 max
18,42
12,9 max
e
5,7
5,3
BeO
metal
0,2 M
3,2
2,9
B
6,35
0,2 M
Ø 0,25 AB
7Z77385.A

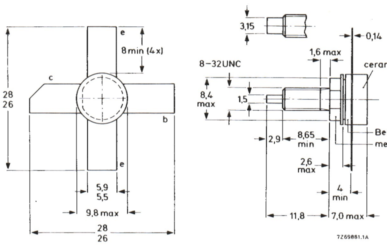
SOT122


e
9 min (4x)
c
28,2
25,4
b
3,05
e
5,9
5,5
7,6 max
28,2
25,4
1,52
8–32UNC
1,98 max
0,17
0,11
ceramic
6,5
6,2
3,3
12
11
BeO
metal
3,2
2,8
5,6 max
7Z76390.A

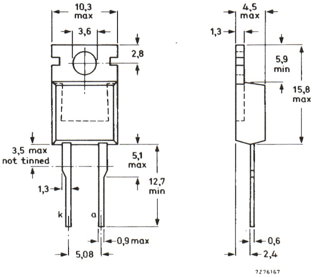
SOT123


A
3,2
2,9
5,9
5,5
5 min
20,6
20,0
B
3,2
2,9
6,35
0,17
0,11
ceramic
25 max
18,42
9,8 max
BeO
Ø 0,25 AB
metal
7Z77386.A

SOT120


e
8 min (4x)
c
28
26
b
e
5,9
5,5
9,8 max
28
26
3,15
0,14
8–32UNC
1,6 max
ceramic
8,4 max
1,5
BeO
metal
2,9
8,65 min
2,6 max
4 min
11,8
7,0 max
7Z69881.1A

BYW-29


10,3 max
3,6
2,8
3,5 max not tinned
5,1 max
12,7 min
1,3
k
a
0,9 max
5,08
4,5 max
1,3
5,9 min
15,8 max
0,6
2,4
7Z76167

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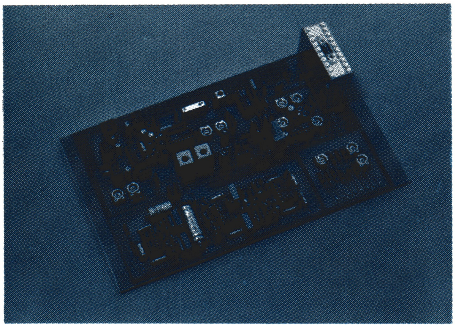
radio-audio



High-frequency section of hi-fi f.m. receiver

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f.m. channel receivers		**TCA420A**	**TBA570A**	**TBA570A** **TCA420A**	**TBA570A**
a.m./f.m. receiver circuits			**TBA570A** **TBA700**	**TBA570A**	**TBA570A**
stereo decoders		**TDA1005** **TCA290A**		**TDA1005**	
stabilizer for electronic tuning		**TCA530** **TCA750**			
d.c. controlled audio circuits	volume and balance	**TCA730**			**TCA730**
	tone	**TCA740**			**TCA740**
	quadruple signal-sources switch	**TDA1028**			
	stereo signal-sources switch	**TDA1029**			

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	5 W audio power amplifier for audio and tv sound	**TDA2611A**
	6 W audio power amplifier for audio and tv sound	**TDA2610; TDA2610A**
	6 W audio power amplifier for car radios and general audio	**TDA1004A**
	6 W audio power amplifier for car radios and general audio	**TDA1010**
	stereo audio power amplifier up to 2 x 10 W	**TDA1009**
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	low level amplifier	**TAA263**
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	f.m. gain block	**ULN2209**
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	f.m. channel receiver	**TBA120SR**
	stereo decoder	**μA758**
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	dual low noise preamplifier	**LM387**
	dual low noise preamplifier	**NE542**
	power driver	**NE541**
	a.m. channel receiver	**TCA440**

consumer
television

For detailed information
Handbook SC5b

vision i.f. demodulators	**TCA270S**	signal processing circuit
	TCA540	synchronous demodulator
	TDA2540	i.f. amplifier (n-p-n tuner) and signal processor
	TDA2541	as TDA2540, but for p-n-p tuner
	TDA2670	i.f. amplifier/demodulator
signal processors	**TBA550, TBA890, TBA900, TDA2680A, TDA2690A**	video preamplifier, automatic horizontal sync and vertical sync separator, etc.
sound circuits	**TBA750A**	limiter-amplifier/demodulator
	TDA2610(A)	output circuit
	TDA2790	limiter-amplifier/demodulator
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	TBA720A	horizontal oscillator circuit
	TDA2571	horizontal oscillator with vertical divider
	TDA2581	horizontal deflection stabilizer
	TDA2590 to 92	horizontal combination
vertical deflection circuit	**TDA2600**	switched mode
colour decoding	**TBA560C, TDA2560**	luminance and chrominance control combination
	TCA660B	contrast, saturation and brightness control for colour difference and luminance signals
	TBA510, TDA2510	chrominance combination
	TCA640	chrominance amplifier for SECAM or PAL/SECAM decoders
	TCA650	chrominance demodulator for SECAM or PAL/SECAM decoders
	TBA540	reference combination
	TAA630S	synchronous demodulator for colour difference drive
	TBA520, TBA990, TCA800	colour demodulator
	TDA2520, TDA2522/23	colour demodulator combination
	TBA530, TDA2530	RGB matrix preamplifier
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professional analogue replacement

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AD101AH	LM101AT
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AD108H	LM108T
AD201AH	LM201AT
AD201AN	LM201AN
AD208AH	LM208AT
AD208H	LM208T
AD301AH	LM301AT
AD301AN	LM301AN
AD308H	LM308T
AD741H	μA741T
AD741N	μA741N
AD741CH	μA741CT
AD741CN	μA741CN
AD559JD	MC1408-8F
AD559K	MC1408-8F
AD559KD	MC1408-8F
AD559S	MC1508-8F
AD559SD	MC1508-8F
AM555DC	NE555F
AM555DM	SE555F
AM555HC	NE555T
AM555HM	SE555T
AM555TC	NE555N
AM723DC	μA723CF
AM723DM	μA723F
AM723HC	μA723CT
AM723HM	μA723T
AM741DC	μA741CF
AM741DM	μA741F
AM741HC	μA741CT
AM741HM	μA741T
AM747DC	μA747CF
AM747DM	μA747F
AM747HC	μA747CT
AM747HM	μA747T
AM748DC	μA748CF
AM748DM	μA748F
AM748HC	μA748CT
AM748HM	μA748T
AMLM101AD	LM101AF
AMLM101AH	LM101AT
AMLM101H	LM101T
AMLM107D	LM107F
AMLM107H	LM107T
AMLM108AH	LM108AH
AMLM108H	LM108T
AMLM111D	LM111F
AMLM111H	LM111T
AMLM201AD	LM201AF
AMLM201AH	LM201AT
AMLM201D	LM201F
AMLM201H	LM201T
AMLM207D	LM207F
AMLM207H	LM207T
AMLM208AH	LM208AT
AMLM208D	LM208F
AMLM211D	LM211F
AMLM211H	LM211T
AMLM301AD	LM301AF
AMLM301AH	LM301AT
AMLM307D	LM307F
AMLM307H	LM307T
AMLM308AH	LM308AT
AMLM308H	LM308T
AMLM311D	LM311F
AMLM311H	LM311T
CA101AF	LM101AF
CA101AT	LM101AT
CA101F	LM101F
CA101T	LM101T
CA107F	LM107F
CA107T	LM107T
CA108AT	LM108AT
CA108T	LM108T
CA111F	LM111F
CA111T	LM111T
CA124F	LM124F
CA139AF	LM139AF
CA139F	LM139F
CA201AF	LM201AF
CA201AT	LM201AT
CA201F	LM201F
CA201T	LM201T
CA207F	LM207F
CA207T	LM207T
CA208T	LM208T
CA211F	LM211F
CA211T	LM211T
CA224F	LM224F
CA239AF	LM239AF
CA239F	LM239F
CA301AF	LM301AF
CA301AT	LM301AT
CA307F	LM307F
CA307T	LM307T
CA308AT	LM308AT
CA308T	LM308T
CA311F	LM311F
CA311T	LM311T
CA324E	LM324N
CA324F	LM324F
CA339E	LM339N
CA339F	LM339F
CA339AE	LM339AN
CA339AF	LM339AF
CA555CE	NE555N
CA555CF	NE555F
CA555CT	NE555T
CA555F	SE555F
CA555T	SE555T
CA723CE	μA723CN
CA723CT	μA723CT
CA723E	μA723N
CA723T	μA723T
CA741CE	μA741CN
CA741CF	μA741CF
CA741CT	μA741CT
CA741F	μA741F
CA741T	μA741T
CA747CF	μA747CF
CA747CT	μA747CT
CA747F	μA747F
CA747T	μA747T
CA748CE	μA748CN
CA748CF	μA748CF
CA748CT	μA748CT
CA748F	μA748F
CA748T	μA748T
CA1458E	MC1458N
CA1458F	MC1458F
CA1458T	MC1458T
CA1558T	MC1558T
CA3045F	CA3045F
CA3046E	CA3046N
CA3081E	CA3081N
CA3082E	CA3082N
CA3083E	CA3083N
CA3086E	CA3086N
CA3183E	CA3183N
DM7820AJ	DS7820AF
DM7820J	DS7820F
DM7830J	DS7830F
DM7880J	DS7880F
DM8820AJ	DS8820AF
DM8820AN	DS8820AN
DM8820J	DS8820F
DM8820N	DS8820N
DM8830J	DS8830F
DM8830N	DS8830N
DM8880J	DS8880F
DM8880N	DS8880N
DS1488J	MC1488F
DS1489AJ	MC1489AF
DS1489J	MC1489F
DS3611H	DS3611T
DS3611N	DS3611N
DS3612H	DS3612T
DS3612N	DS3612N
DS3613H	DS3613T
DS3613N	DS3613N
DS3614H	DS3614T
DS3614N	DS3614N
DS7520J	7520F

type to be replaced	replacement
DS7520N	7520N
DS7521J	7521F
DS7521N	7521N
DS7522J	7522F
DS7522N	7522N
DS7523J	7523F
DS7523N	7523N
DS7524J	7524F
DS7524N	7524N
DS7525J	7525F
DS7525N	7525N
DS7528J	7528F
DS7528N	7528N
DS7820AJ	DS7820AF
DS7820J	DS7820F
DS7830J	DS7830F
DS7880J	DS7880F
DS8820J	DS8820F
DS8820AJ	DS8820AF
DS8820AN	DS8820AN
DS8820N	DS8820N
DS8830J	DS8830F
DS8830N	DS8830N
DS8880J	DS8880F
DS8880N	DS8880N
DS55450J	55450BF
DS55450T	55450BT
DS55451H	55451BT
DS55452H	55452BT
DS55453H	55453BT
DS55454H	55454BT
DS75107J	75S107F
DS75107N	75S107N
DS75108J	75S108F
DS75108N	75S108N
DS75207J	75S207F
DS75207N	75S207N
DS75208J	75S208F
DS75208N	75S208N
DS75324J	75324F
DS75324N	75324N
DS75325J	75325F
DS75325N	75325N
DS75450J	75450BF
DS75450N	75450BN
DS75451H	75451BT
DS75451N	75451BN
DS75452H	75452BT
DS75452N	75452BN
DS75453H	75453BT
DS75453N	75453BN
DS75454H	75454BT
DS75454N	75454BN
LF155AH	LF155AT
LF155AJ-8	LF155AFE
LF155AL	LF155AT
LF155H	LF155T
LF155J-8	LF155FE
LF155L	LF155T
LF156AH	LF156AT
LF156AJ-8	LF156AFE
LF156AL	LF156AT
LF156H	LF156AT
LF156J-8	LF156FE
LF156L	LF156T
LF157AH	LF157AT
LF157AJ-8	LF157AFE
LF157AL	LF157AT
LF157H	LF157T
LF157J-8	LF157FE
LF157L	LF157T
LF255AL	LF255AT
LF255L	LF255T
LF256AL	LF256AT
LF256L	LF256T
LF257AL	LF257AT
LF257L	LF257T
LF355AH	LF355AT
LF355AJ-8	LF355AFE
LF355AL	LF355AT
LF355AN	LF355AN
LF355H	LF355T
LF355J-8	LF355FE
LF355L	LF355T
LF355N	LF355N
LF356AH	LF356AT
LF356AJ-8	LF356AFE
LF356AL	LF356AT
LF356AN	LF356AN
LF356H	LF356T
LF356J-8	LF356FE
LF356L	LF356T
LF356N	LF356N
LF357AH	LF357AT
LF357AJ-8	LF357AFE
LF357AL	LF357AT
LF357AN	LF357AN
LF357H	LF357T
LF357J-8	LF357FE
LF357L	LF357T
LF357N	LF357N
LH2101AD	LH2101AF
LH2108AD	LH2108AF
LH2108D	LH2108F
LH2111D	LH2111F
LH2201AD	LH2201AF
LH2208AD	LH2208AF
LH2208D	LH2208F
LH2211D	LH2211F
LH2301AD	LH2301AF
LH2308AD	LH2308AF
LH2308D	LH2308F
LH2311D	LH2311F
LM78L05ACH	78L05ACDB
LM78L05ACZ	78L05ACS
LM78L05CH	78L05CDB
LM78L05CZ	78L05CS
LM78L06ACH	78L06ACDB
LM78L06ACZ	78L06ACS
LM78L06CH	78L06CDB
LM78L06CZ	78L06CS
LM78L08ACH	78L08ACDB
LM78L08ACZ	78L08ACS
LM78L08CH	78L08CDB
LM78L08CZ	78L08CS
LM78L12ACH	78L12ACDB
LM78L12ACZ	78L12ACS
LM78L12CH	78L12CDB
LM78L12CZ	78L12CS
LM78L15ACH	78L15ACDB
LM78L15ACZ	78L15ACS
LM78L15CH	78L15CDB
LM78L15CZ	78L15CS
LM78L24ACH	78L24ACDB
LM78L24ACZ	78L24ACS
LM78L24CH	78L24CDB
LM78L24CZ	78L24CS
LM101AD	LM101AF
LM101AH	LM101AT
LM101AJ	LM101AF
LM101AJ-14	LM101AF
LM101AJG	LM101AFE
LM101AL	LM101AT
LM101H	LM101T
LM101J-14	LM101F
LM107D	LM107F
LM107H	LM107T
LM107J	LM107F or FE
LM107J-14	LM107F
LM107JG	LM107FE
LM107L	LM107T
LM108AD	LM108AF
LM108AH	LM108AT
LM108AJ	LM108AF
LM108D	LM108F
LM108H	LM108T
LM108J	LM108F
LM109H	LM109DB
LM109K	LM109DA
LM109LA	LM109DB
LM111D	LM111F
LM111H	LM111T
LM111J	LM111F
LM111JG	LM111FE
LM111L	LM111T

professional analogue replacement

type to be replaced	replacement	type to be replaced	replacement	type to be replaced	replacement
LM119D	LM119F	LM219J	LM219F	LM319D	LM319F
LM119H	LM119T	LM224AD	LM224AF	LM319H	LM319T
LM119J	LM119F	LM224AJ	LM224AF	LM319J	LM319F
LM124AD	LM124AF	LM224D	LM224F	LM319N	LM319N
LM124AJ	LM124AF	LM224J	LM224F	LM324AJ	LM324AF
LM124D	LM124F	LM224N	LM224N	LM324AN	LM324AN
LM124J	LM124F	LM239AD	LM239AF	LM324J	LM324F
LM139AD	LM139AF	LM239AJ	LM239AF	LM324N	LM324N
LM139AJ	LM139AF	LM239D	LM239F	LM339AJ	LM339AF
LM139D	LM139F	LM239J	LM239F	LM339AN	LM339AN
LM139J	LM139F	LM239N	LM239N	LM339J	LM339F
LM158AH	LM158AT	LM258AH	LM258AT	LM339N	LM339N
LM158H	LM158T	LM258H	LM258T	LM340K-5.0	LM340-5DA
LM158JG	LM158FE	LM258JG	LM258FE	LM340K-6.0	LM340-6DA
LM158L	LM158T	LM258L	LM258T	LM340K-8.0	LM340-8DA
LM161D	SE529F	LM258P	LM258N	LM340K-12	LM340-12DA
LM161H	SE529K	LM293AH	LM293AT	LM340K-15	LM340-15DA
LM161J	SE529F	LM293H	LM293T	LM340K-18	LM340-18DA
LM193AH	LM193AT	LM293JG	LM293FE	LM340K-24	LM340-24DA
LM193H	LM193T	LM293L	LM293T	LM340T-5.0	LM340-5U
LM193JG	LM193FE	LM293P	LM293N	LM340T-6.0	LM340-6U
LM193L	LM193T	LM301AH	LM301AT	LM340T-8.0	LM340-8U
LM201AD	LM201AF	LM301AJ	LM301AF or AFE	LM340T-12	LM340-12U
LM201AH	LM201AT	LM301AJ-14	LM301AF	LM340T-15	LM340-15U
LM201AJ	LM201AF	LM301AJG	LM301AFE	LM340T-18	LM340-18U
LM201AJ-14	LM201AF	LM301AL	LM301AT	LM340T-24	LM340-24U
LM201AJG	LM201AFE	LM301AN	LM301AN or AN-14	LM341P-5.0	78M05CU
LM201AL	LM201AT	LM301AP	LM301AN	LM341P-6.0	78M06CU
LM201AN	LM201AN-14	LM307D	LM307F	LM341P-8.0	78M08CU
LM201AP	LM201AN	LM307H	LM307T	LM341P-12	78M12CU
LM201H	LM201T	LM307J	LM307F or FE	LM341P-15	78M15CU
LM201J	LM201FE	LM307J-14	LM307F	LM341P-20	78M20CU
LM201J-14	LM201F	LM307JG	LM307FE	LM341P-24	78M24CU
LM207D	LM207F	LM307L	LM307T	LM358AH	LM358AT
LM207H	LM207T	LM307N	LM307N or N-14	LM358AN	LM358AN
LM207J	LM207F or FE	LM307P	LM307N	LM358H	LM358T
LM207J-14	LM207F	LM308AD	LM308AF	LM358JG	LM358FE
LM207JG	LM207FE	LM308AH	LM308AT	LM358L	LM358T
LM207L	LM207T	LM308AJ	LM308AF	LM358N	LM358N
LM207N	LM207N-14	LM308D	LM308F	LM358P	LM358N
LM207P	LM207N	LM308H	LM308T	LM361D	LM361F
LM208AD	LM208AF	LM308J	LM308F	LM361H	LM361T
LM208AH	LM208AT	LM308N	LM308N	LM361J	LM361F
LM208AJ	LM208AF	LM309H	LM309DB	LM361N	LM361N
LM208D	LM208F	LM309K	LM309DA	LM381N	LM381N
LM208H	LM208T	LM309LA	LM309DB	LM382N	LM382N
LM208J	LM208F	LM311D	LM311F	LM387N	LM387N
LM209H	LM209DB	LM311H	LM311T	LM393AH	LM393AT
LM209K	LM209DA	LM311J	LM311F or FE	LM393AN	LM393AN
LM209LA	LM209DB	LM311J-14	LM311F	LM393H	LM393T
1LM211D	LM211F	LM311JG	LM311FE	LM393JG	LM393FE
LM211H	LM211T	LM311L	LM311T	LM393L	LM393T
LM211J	LM211F	LM311N	LM311N or N-14	LM393N	LM393N
LM219D	LM219F	LM311N-14	LM311N-14	LM393P	LM393N
LM219H	LM219T	LM311P	LM311N	LM555CH	NE555T

type to be replaced	replacement
LM555CN	NE555N
LM555H	SE555T
LM556CD	NE556F
LM556CJ	NE556F
LM556CN	NE556N
LM556D	SE556F
LM556J	SE556F
LM565CH	NE565T
LM565CN	NE565N
LM565H	SE565T
LM566CH	NE566T
LM566CN	NE566N
LM566H	SE566T
LM567CH	NE567T
LM567CN	NE567N
LM567H	SE567T
LM709AJ	μA709AF
LM709CH	μA709CT
LM709CJ	μA709CF
LM709CN	μA709CN
LM709CN-14	μA709CN-14
LM709H	μA709T
LM709J	μA709F
LM710H	μA710T
LM710CH	μA710CT
LM711CH	μA711CT
LM711CN	μA711CN
LM711H	μA711T
LM723CD	μA723CF
LM723CH	μA723CT
LM723CJ	μA723CF
LM723CN	μA723CN
LM723D	μA732F
LM723H	μA723T
LM723J	μA723F
LM723N	μA723N
LM733CD	μA733CF
LM733CH	μA733CT
LM733CJ	μA733CF
LM733CN	μA733CN
LM733D	μA733F
LM733H	μA733T
LM733T	μA733F
LM741CH	μA741CT
LM741CJ	μA741CFE
LM741CJ-14	μA741CF
LM741CN	μA741CN
LM741CN-14	μA741CN-14
LM741D	μA741F
LM741H	μA741T
LM741J-14	μA741F
LM747CD	μA747CF
LM747CH	μA747CT
LM747CJ	μA747CF
LM747D	μA747F
LM747H	μA747T
LM747J	μA747F
LM748CH	μA748CT
LM748CJ	μA748CF
LM748CN	μA748CN
LM748H	μA748T
LM748J	μA748F
LM1458H	MC1458T
LM1458J	MC1458FE
LM1458N	MC1458N
LM1458N-14	MC1458N-14
LM1496H	MC1496T
LM1496J	MC1496F
LM1496N	MC1496N
LM1558H	MC1558T
LM1558J	MC1558FE
LM1596H	MC1596T
LM1596J	MC1596F
LM2901J	LM2901F
LM2901N	LM2901N
LM2902J	LM2902F
LM2902N	LM2902N
LM2903JG	LM2903FE
LM2903L	LM2903T
LM2903N	LM2903N
LM2903P	LM2903N
LM2904JG	LM2904FE
LM2904L	LM2904T
LM2904N	LM2904N
LM2904P	LM2904N
LM3045D	CA3045F
LM3045J	CA3045F
LM3046N	CA3046N
LM3086N	CA3086N
LM3302N	MC3302N
LM7805KC	7805CDA
LM7805T	7805CU
LM7806KC	7806CDA
LM7806T	7806CU
LM7808KC	7808CDA
LM7808T	7808CU
LM7812KC	7812CDA
LM7812T	7812CU
LM7815KC	7815CDA
LM7815T	7815CU
LM7818KC	7818CDA
LM7818T	7818CU
LM7824KC	7824CDA
LM7824T	7824CU
LM7905T	7905CU
LM7905.2T	7905.2CU
LM7906T	7906CU
LM7908T	7908CU
LM7912T	7912CU
LM7915T	7915CU
LM7918T	7918CU
LM7924T	7924CU
MC78L02ACG	78L02ACDB
MC78L02ACP	78L02ACS
MC78L05ACG	78L05ACDB
MC78L05ACP	78L05ACS
MC78L05CG	78L05CDB
MC78L05CP	78L05CS
MC78L08ACG	78L08ACDB
MC78L08ACP	78L08ACS
MC78L08CG	78L08CDB
MC78L08CP	78L08CS
MC78L12ACG	78L12ACDB
MC78L12ACP	78L12ACS
MC78L12CG	78L12CDB
MC78L12CP	78L12CS
MC78L15ACG	78L15ACDB
MC78L15ACP	78L15ACS
MC78L15CG	78L15CDB
MC78L15CP	78L15CS
MC78L18ACG	78L18ACDB
MC78L18ACP	78L18ACS
MC78L18CG	78L18CDB
MC78L18CP	78L18CS
MC78L24ACG	78L24ACDB
MC78L24ACP	78L24ACS
MC78L24CG	78L24CDB
MC78L24CP	78L24CS
MC78M05CG	78M05CDB
MC78M05CT	78M05CU
MC78M06CG	78M06CDB
MC78M06CT	78M06CU
MC78M08CG	78M08CDB
MC78M08CT	78M08CU
MC78M12CG	78M12CDB
MC78M12CT	78M12CU
MC78M15CG	78M15CDB
MC78M15CT	78M15CU
MC78M18CG	78M18CDB
MC78M18CT	78M18CU
MC78M20CG	78M20CDB
MC78M20CT	78M20CU
MC78M24CG	78M24CDB
MC78M24CT	78M24CU
MC1408L6	MC1408-6F
MC1408L7	MC1408-7F
MC1408L8	MC1408-8F
MC1408P6	MC1408-6N
MC1408P7	MC1408-7N
MC1408P8	MC1408-8N
MC1411P	ULN2001N
MC1412P	ULN2002N
MC1413P	ULN2003N
MC1416P	ULN2004N
MC1455G	NE555T

professional analogue replacement

type to be replaced	replacement
MC1455P1	NE555N
MC1455U	NE555FE
MC1456CG	MC1456T
MC1456CL	MC1456F
MC1456CP1	MC1456N
MC1456CU	MC1456FE
MC1456G	MC1456T
MC1456L	MC1456F
MC1456P1	MC1456N
MC1456U	MC1456FE
MC1458CG	MC1458T
MC1458CL	MC1458F
MC1458CP1	MC1458N
MC1458CP2	MC1458N-14
MC1458CU	MC1458FE
MC1458G	MC1458T
MC1458JG	MC1458FE
MC1458L	MC1458F or T
MC1458P	MC1458N
MC1458P1	MC1458N
MC1458P2	MC1458N-14
MC1458SG	NE5535T
MC1458SL	NE5535F
MC1458SP1	NE5535N
MC1458SP2	NE5535N-14
MC1458SU	NE5535FE
MC1458U	MC1458FE
MC1471P1	UDN5711N
MC1472P1	UDN5712N
MC1473P1	UDN5713N
MC1474P1	UDN5714N
MC1488L	MC1488F
MC1489AL	MC1489AF
MC1489L	MC1489F
MC1496G	MC1496T
MC1496L	MC1496F
MC1496P	MC1496N
MC1508L8	MC1508-8F
MC1555G	SE555T
MC1555U	SE555FE
MC1556G	MC1556T
MC1556L	MC1556F
MC1556U	MC1556FE
MC1558G	MC1558T
MC1558JG	MC1558FE
MC1558L	MC1558F or T
MC1558SG	SE5535T
MC1558SL	SE5535F
MC1558SU	SE5535FE
MC1558U	MC1558FE
MC1596G	MC1596T
MC1596L	MC1596F
MC1709AG	μA709AT
MC1709AL	μA709AF
MC1709CG	μA709CT
MC1709CL	μA709CF
MC1709CP1	μA709CN
MC1709CP2	μA709CN14
MC1709CU	μA709CFE
MC1709G	μA709T
MC1709L	μA709F
MC1709U	μA709FE
MC1710CG	μA710CT
MC1710CL	μA710CF
MC1710CP	μA710CN
MC1710G	μA710T
MC1710L	μA710F
MC1711CG	μA711CT
MC1711CL	μA711CF
MC1711CP	μA711CN
MC1711G	μA711T
MC1711L	μA711F
MC1723CG	μA723CT
MC1723CL	μA723CF
MC1723CP	μA723CN
MC1723G	μA723T
MC1723L	μA723F
MC1733CG	μA733CT
MC1733CL	μA733CF
MC1733CP	μA733CN
MC1733G	μA733T
MC1733L	μA733F
MC1741CG	μA741CT
MC1741CL	μA741CF
MC1741CP1	μA741CN
MC1741CP2	μA741CN-14
MC1741CU	μA741CFE
MC1741G	μA741T
MC1741L	μA741F
MC1741SCG	NE535T
MC1741SCP1	NE535N
MC1741SCU	NE535FE
MC1741SG	SE535T
MC1741SU	SE535FE
MC1741U	SE535FE
MC1747CG	μA747CT
MC1747CL	μA747CF
MC1747CP2	μA747CN
MC1747G	μA747T
MC1747L	μA747F
MC1748CG	μA748CT
MC1748CP1	μA748CN
MC1748CU	μA748CFE
MC1748G	μA748T
MC1748U	μA748FE
MC3302L	MC3302F
MC3302P	MC3302N
MC3346P	CA3046N
MC3386P	CA3086N
MC3456L	NE556F
MC3456P	NE556N
MC3556L	SE556F
MC7524L	7524F
MC7524P	7524N
MC7525L	7525F
MC7525P	7525N
MC7528L	7528F
MC7528P	7528N
MC7529L	7529F
MC7529P	7529N
MC7805CK	7805CDA
MC7805CT	7805CU
MC7806CK	7806CDA
MC7806CT	7806CU
MC7808CK	7808CDA
MC7808CT	7808CU
MC7812CK	7812CDA
MC7812CT	7812CU
MC7815CK	7815CDA
MC7815CT	7815CU
MC7818CK	7818CDA
MC7818CT	7818CU
MC7824CK	7824CDA
MC7824CT	7824CU
MC7902CK	79M02CDA
MC7902CT	79M02CU
MC7905CK	79M05CDA
MC7905CT	79M05CU
MC7905.2CK	7905.2CDA
MC7905.2CT	7905.2CU
MC7906CK	7906CDA
MC7906CT	7906CU
MC7908CK	7908CDA
MC7908CT	7908CU
MC7912CK	7912CDA
MC7912CT	7912CU
MC7915CK	7915CDA
MC7915CT	7915CU
MC7918CK	7918CDA
MC7918CT	7918CU
MC7924CK	7924CDA
MC7924CT	7924CU
MC55325L	55325F
MC75107L	75S107F
MC75107P	75S107N
MC75108L	75S108F
MC75108P	75S108N
MC75324L	75324F
MC75324P	75324N
MC75450L	75450F
MC75450P	75450N
MC75451P	75451N
MC75451U	75451FE
MC75452P	75452N
MC75452U	75452FE

type to be replaced	replacement
MC75453P	75453N
MC75453U	75453FE
MC75454P	75454N
MC75454U	75454FE
MLM101AG	LM101AT
MLM101AU	LM101AFE
MLM107G	LM107T
MLM107U	LM107FE
MLM108G	LM108T
MLM108L	LM108F
MLM108AG	LM108AT
MLM108AL	LM108AF
MLM109G	LM109DB
MLM109K	LM109DA
MLM111G	LM111T
MLM111L	LM111F
MLM111U	LM111FE
MLM124L	LM124F
MLM139AL	LM139AF
MLM139L	LM139F
MLM158G	LM158T
MLM158U	LM158FE
MLM201AG	LM201AT
MLM201AP1	LM201AN
MLM201AU	LM201AFE
MLM207G	LM207T
MLM207U	LM207FE
MLM208AG	LM208AT
MLM208AL	LM208AF
MLM208G	LM208T
MLM208L	LM208F
MLM209G	LM209DB
MLM209K	LM209DA
MLM211G	LM211T
MLM211L	LM211F
MLM211U	LM211FE
MLM224L	LM224F
MLM224P	LM224N
MLM239AL	LM239AF
MLM239AP	LM239AN
MLM239L	LM239F
MLM239P	LM239N
MLM258G	LM258T
MLM258P1	LM258N
MLM258U	LM258FE
MLM301AG	LM301AT
MLM301AP1	LM301AN
MLM301AU	LM301AFE
MLM307G	LM307T
MLM307P1	LM307N
MLM307U	LM307FE
MLM308AG	LM308AT
MLM308AL	LM308AF
MLM308G	LM308T
MLM308L	LM308F
MLM308P1	LM308N
MLM309G	LM309DB
MLM309K	LM309DA
MLM311G	LM311T
MLM311L	LM311F
MLM311P1	LM311N
MLM311U	LM311FE
MLM324L	LM324F
MLM324P	LM324N
MLM339AL	LM339AF
MLM339AP	LM339AN
MLM339L	LM339F
MLM339P	LM339N
MLM358G	LM358T
MLM358P1	LM358N
MLM358U	LM358FE
MLM565CP	NE565CN
MLM2901P	LM2901N
MLM2902P	LM2902N
μA78GU1C	78GCU1
μA78L02ACLP	78L02ACS
μA78L02CLP	78L02CS
μA78L05ACLP	78L05ACS
μA78L05AHC	78L05ACDB
μA78L05AWC	78L05ACS
μA78L05CLP	78L05CS
μA78L06ACLP	78L06ACS
μA78L06AHC	78L06ACDB
μA78L06AWC	78L06ACS
μA78L06CLP	78L06CS
μA78L08ACLP	78L08ACS
μA78L08CLP	78L08CS
μA78L12ACLP	78L12ACS
μA78L12AHC	78L12ACDB
μA78L12AWC	78L12ACS
μA78L12CLP	78L12CS
μA78L15ACLP	78L15ACS
μA78L15AHC	78L15ACDB
μA78L15AWC	78L15ACS
μA78L15CLP	78L15CS
μA78L26AWC	78L02ACS
μA78L82AHC	78L08ACDB
μA78L82AWC	78L08ACS
μA78M05CKC	78M05CU
μA78M05CLA	78M05CDB
μA78M05HC	78M05CDB
μA78M05HM	78M05DB
μA78M05MLA	78M05DB
μA78M05UC	78M05CU
μA78M06CKC	78M06CU
μA78M06CLA	78M06CDB
μA78M06HC	78M06CDB
μA78M06HM	78M06DB
μA78M06MLA	78M06DB
μA78M06UC	78M06CU
μA78M08CKC	78M08CU
μA78M08CLA	78M08CDB
μA78M08HC	78M08CDB
μA78M08HM	78M08DB
μA78M08MLA	78M08DB
μA78M08UC	78M08CU
μA78M12CKC	78M12CU
μA78M12CLA	78M12CDB
μA78M12HC	78M12CDB
μA78M12HM	78M12DB
μA78M12MLA	78M12DB
μA78M12UC	78M12CU
μA78M15CKC	78M15CU
μA78M15CLA	78M15CDB
μA78M15HC	78M15CDB
μA78M15HM	78M15DB
μA78M15MLA	78M15DB
μA78M15UC	78M15CU
μA78M20CKC	78M20CU
μA78M20CLA	78M20CDB
μA7820HC	78M20CDB
μA78M20HM	78M20DB
μA78M20MLA	78M20DB
μA78M20UC	78M20CU
μA78M24CKC	78M24CU
μA78M24CLA	78M24CDB
μA78M24HC	78M24CDB
μA78M24HM	78M24DB
μA78M24MLA	78M24DB
μA78M24UC	78M24CU
μA78MGU1C	78MGCU1
μA79GU1C	79GCU1
μA79M05	79M05DB
μA79M05AHC	79M05CDB
μA79M05AUC	79M05CU
μA79M05CKC	79M05CU
μA79M05CLA	79M05CDB
μA79M05HM	79M05DB
μA79M06AHC	79M06CDB
μA79M06AUC	79M06CU
μA79M06CKC	79M06CU
μA79M06CLA	79M06CDB
μA79M06HM	79M06DB
μA79M06LA	79M06DB
μA79M08AHC	79M08CDB
μA79M08AUC	79M08CU
μA79M08CKC	79M08CU
μA79M08CLA	79M08CDB
μA79M08HM	79M08DB
μA79M08LA	79M08DB
μA79M12AHC	79M12CDB
μA79M12AUC	79M12CU
μA79M12CKC	79M12CU
μA79M12CLA	79M12CDB
μA79M12HM	79M12DB

professional analogue replacement

type to be replaced	replacement	type to be replaced	replacement	type to be replaced	replacement
µA79M12LA	79M12DB	µA311HC	LM311T	µA711CL	µA711CT
µA79M15AHC	79M15CDB	µA311TC	LM311N	µA711CN	µA711CN
µA79M15AUC	79M15CU	µA324DC	LM324F	µA711DC	µA711CF
µA79M15CKC	79M15CU	µA324PC	LM324N	µA711DM	µA711F
µA79M15CLA	79M15CDB	µA339ADC	LM339AF	µA711MJ	µA711F
µA79M15HM	79M15DB	µA339DC	LM339F	µA711ML	µA711T
µA79M15LA	79M15DB	µA339PC	LM339N	µA711PC	µA711CN
µA79M18AHC	79M18CDB	µA555HC	NE555T	µA723CJ	µA723CF
µA79M18AUC	79M18CU	µA555HM	SE555T	µA723CL	µA723CT
µA79M18HM	79M18DB	µA555TC	NE555N	µA723CN	µA723CN
µA79M20CKC	79M20CU	µA556DC	NE556F	µA723DC	µA723CF
µA79M20CLA	79M20CDB	µA556DM	SE556F	µA723DM	µA723F
µA79M20LA	79M20DB	µA556PC	NE556N	µA723HC	µA723CT
µA79M24AHC	79M24CDB	µA709	µA709T	µA723HM	µA723T
µA79M24AUC	79M24CU	µA709ADM	µA709AF	µA723MJ	µA723F
µA79M24CKC	79M24CU	µA709AHM	µA709AT	µA723ML	µA723T
µA79M24CLA	79M24CDB	µA709AJ	µA709AF	µA723PC	µA723CN
µA79M24HM	79M24DB	µA709AJG	µA709AFE	µA733CJ	µA733CF
µA79M24LA	79M24DB	µA709AL	µA709AT	µA733CL	µA733CT
µA79MGU1C	79MGCU1	µA709C1	µA709CT	µA733CN	µA733CN
µA101ADM	LM101AF	µA709C2	µA709CN	µA733DC	µA733CF
µA101AHM	LM101AT	µA709CJ	µA709CF	µA733DM	µA733F
µA101DM	LM101F	µA709CJG	µA709CFE	µA733HC	µA733CT
µA101HM	LM101T	µA709CL	µA709CT	µA733HM	µA733T
µA107HM	LM107T	µA709CN	µA709CN-14	µA733MJ	µA733F
µA108ADM	LM108AF	µA709CP	µA709CN	µA733ML	µA733T
µA108AHM	LM108AT	µA709DC	µA709CF	µA740HC	µA740CT
µA108DM	LM108F	µA709DM	µA709F	µA741CJ	µA741CF
µA108HM	LM108T	µA709HC	µA709CT	µA741CJG	µA741CFE
µA109KM	LM109DA	µA709HM	µA709T	µA741CL	µA741CT
µA111HM	LM111T	µA709MJ	µA709F	µA741CN	µA741CN-14
µA124DM	LM124F	µA709MJG	µA709FE	µA741CP	µA741CN
µA139ADM	LM124AF	µA709ML	µA709T	µA741DC	µA741CF
µA139DM	LM124F	µA709PC	µA709CN-14	µA741DM	µA741F
µA201AHD	LM201AF	µA709TC	µA709CN	µA741HC	µA741CT
µA201AHM	LM201AT	µA710	µA710T	µA741HM	µA741T
µA201DM	LM201F	µA710C1	µA710CT	µA741MJ	µA741F
µA201HM	LM201T	µA710C2	µA710CN	µA741MJG	µA741FE
µA207HM	LM207T	µA710CJ	µA710CF	µA741ML	µA741T
µA208ADM	LM208AF	µA710CJG	µA710CFE	µA741PC	µA741CN-14
µA208AHM	LM208AT	µA710CL	µA710CT	µA741TC	µA741CN
µA208DM	LM208F	µA710CN	µA710CN-14	µA747CJ	µA747CF
µA208HM	LM208T	µA710CP	µA710CN	µA747CL	µA747CT
µA209KM	LM209DA	µA710DC	µA710CF	µA747CN	µA747CN
µA224DM	LM224F	µA710DM	µA710F	µA747DC	µA747CF
µA301ADC	LM301AF	µA710HC	µA710CT	µA747DM	µA747F
µA301AHC	LM301AT	µA710HM	µA710T	µA747HC	µA747CT
µA301ANC	LM301AN	µA710MJ	µA710F	µA747HM	µA747T
µA307HC	LM307T	µA710MJG	µA710FE	µA747MJ	µA747F
µA307TC	LM307N	µA710ML	µA710T	µA747ML	µA747T
µA308ADC	LM308AF	µA710PC	µA710CN-14	µA747PC	µA747CN
µA308AHC	LM308AT	µA711	µA711K	µA748CJ	µA748CF
µA308DC	LM308F	µA711C1	µA711CK	µA748CJG	µA748CFE
µA308HC	LM308T	µA711C2	µA711CN	µA748CL	µA748CT
µA308TC	LM308N	µA711CJ	µA711CF	µA748CN	µA748CN-14

type to be replaced	replacement	type to be replaced	replacement	type to be replaced	replacement
µA748CP	µA748CN	µA7818CKA	7818CDA	µAF155HM	LF155T
µA748DC	µA748CF	µA7818CKC	7818CU	µAF156AHM	LF156AT
µA748DM	µA748F	µA7818KC	7818CDA	µAF156HM	LF156T
µA748HC	µA748CT	µA7818KM	7818DA	µAF157AHM	LF157AT
µA748HM	µA748T	µA7818MKA	7818DA	µAF157HM	LF157T
µA748MJ	µA748F	µA7818UC	7818CU	µAF355AHC	LF355AT
µA748MJG	µA748FE	µA7824CKA	7824CDA	µAF355HC	LF355T
µA748ML	µA748T	µA7824CKC	7824CU	µAF356AHC	LF356AT
µA748TC	µA748CN	µA7824KC	7824CDA	µAF356HC	LF356T
µA796HC	MC1496T	µA7824KM	7824DA	µAF357AHC	LF357AT
µA0802DC-1	MC1408-8F	µA7824MKA	7824DA	µAF357HC	LF357T
µA0802DC-2	MC1408-7F	µA7824UC	7824CU	NE555JG	NE555FE
µA0802DC-3	MC1408-6F	µA7905CKA	7905CDA	NE555L	NE555T
µA0802DM-1	MC1508-8F	µA7905CKC	7905CU	NE555P	NE555N
µA0802PC-1	MC1408-8N	µA7905KA	7905DA	NE592G	NE592T
µA0802PC-2	MC1408-7N	µA7905KC	7905CDA	NE592L	NE592F
µA0802PC-3	MC1408-6N	µA7905KM	7905DA	RC709D	µA709CF
µA1458HC	MC1458T	µA7905UC	7905CU	RC709DN	µA709CN
µA1458TC	MC1458N	µA7906CKA	7906CDA	RC709DP	µA709CN-14
µA1558HM	MC1558T	µA7906CKC	7906CU	RC709T	µA709CT
µA2901PC	LM2901N	µA7906KA	7906DA	RC710DC	µA710CF
µA2902PC	LM2902N	µA7906KC	7905CDA	RC710DP	µA710CN
µA3045DM	CA3045F	µA7906KM	7905DA	RC710T	µA710CT
µA3046TC	CA3046N	µA7906UC	7905CU	RC711DC	µA711CF
µA3086TC	CA3086N	µA7908CKA	7908CDA	RC711DP	µA711CN
µA7805CKA	7805CDA	µA7908CKC	7908CU	RC711T	µA711CT
µA7805CKC	7805CU	µA7908KA	7908DA	RC723D	µA723CF
µA7805KC	7805CDA	µA7908KC	7908CDA	RC723T	µA723CT
µA7805KM	7805DA	µA7908KM	7908DA	RC733D	µA733CF
µA7805MKA	7805DA	µA7908UC	7908CU	RC733T	µA733CT
µA7805UC	7805CU	µA7912CKA	7912CDA	RC741D	µA741CF
µA7806CKA	7806CDA	µA7912CKC	7912CU	RC741DN	µA741CN
µA7806CKC	7806CU	µA7912KA	7912DA	RC741DP	µA741CN-14
µA7806KC	7806CDA	µA7912KC	7912CDA	RC741T	µA741CT
µA7806KM	7806DA	µA7912KM	7912DA	RC747D	µA747CF
µA7806MKA	7806DA	µA7912UC	7912CU	RC747T	µA747CT
µA7806UC	7806CU	µA7915CKA	7915CDA	RC748T	µA748CT
µA7808CKA	7808CDA	µA7915CKC	7915CU	RC1458DN	MC1458N
µA7808CKC	7808CU	µA7915KA	7915DA	RC1458T	MC1458T
µA7808KC	7808CDA	µA7915KC	7915CDA	RC1488DC	MC1488F
µA7808KM	7808DA	µA7915KM	7915DA	RC1489ADC	MC1489AF
µA7808MKA	7808DA	µA7915UC	7915CU	RC1489DC	MC1489F
µA7808UC	7808CU	µA7918CKA	7918CDA	RC1556T	MC1456T
µA7812CKA	7812CDA	µA7918CKC	7918CU	SE555JG	SE555FE
µA7812CKC	7812CU	µA7918KA	7918DA	SE555L	SE555T
µA7812KC	7812CDA	µA7918KC	7918CDA	SE592G	SE592T
µA7812KM	7812DA	µA7918KM	7918DA	SE592L	SE592F
µA7812MKA	7812DA	µA7918UC	7918CU	SFC2101A	LM101AT
µA7812UC	7812CU	µA7924CKA	7924CDA	SFC2107M	LM107T
µA7815CKA	7815CDA	µA7924CKC	7924CU	SFC2111M	LM111T
µA7815CKC	7815CU	µA7924KA	7924DA	SFC2201A	LM201AT
µA7815KC	7815CDA	µA7924KC	7924CDA	SFC2207	LM207T
µA7815KM	7815DA	µA7924KM	7924DA	SFC2208	LM208T
µA7815MKA	7815DA	µA7924UC	7924CU	SFC2211	LM211T
µA7815UC	7815CU	µAF155AHM	LF155AT	SFC2301A	LM301AT

professional analogue replacement

type to be replaced	replacement
SFC2301ADC	LM301AN
SFC2307	LM307T
SFC2308	LM308T
SFC2309	LM309DA
SFC2311	LM311T
SFC2709C	μA709CT
SFC2709EC	μA709CN
SFC2709EM	μA709N
SFC2709M	μA709T
SFC2710C	μA710CT
SFC2710EC	μA710CN
SFC2710EM	μA710N
SFC2710M	μA710T
SFC2711C	μA711CK
SFC2711EC	μA711CN
SFC2711EM	μA711N
SFC2711M	μA711K
SFC2741C	μA741CT
SFC2741DC	μA741CV
SFC2741EC	μA741CN
SFC2741EM	μA741N
SFC2741M	μA741T
SFC2748C	μA748CT
SFC2748DC	μA748CV
SN7520J	7520F
SN7520N	7520N
SN7521J	7521F
SN7521N	7521N
SN7522J	7522F
SN7522N	7522N
SN7523J	7523F
SN7523N	7523N
SN7524J	7524F
SN7524N	7524N
SN7525J	7525F
SN7525N	7525N
SN7528J	7528F
SN7528N	7528N
SN52101AJ	LM101AF
SN52101AL	LM101AT
SN52107J	LM107F
SN52107L	LM107T
SN52108AJ	LM108AF
SN52108AL	LM108AT
SN52108J	LM108F
SN52108L	LM108T
SN52109LA	LM109DB
SN52111J	LM111F
SN52111T	LM111T
SN52555L	SE555T
SN52558L	MC1558T
SN52709AJ	μA709AF
SN52709AL	μA709AT
SN52709J	μA709F
SN52709L	μA709T
SN52710J	μA710F
SN52710L	μA710T
SN52711J	μA711F
SN52711L	μA711T
SN52723J	μA723F
SN52723L	μA723T
SN52733J	μA733F
SN52733L	μA733T
SN52741J	μA741F
SN52741L	μA741T
SN52747J	μA747F
SN52747L	μA747T
SN52748J	μA748F
SN52748L	μA748T
SN52771J	MC1556F
SN52771L	MC1556T
SN55182J	DS7820F
SN55182N	DS7820N
SN55183J	DS7830F
SN55183N	DS7830N
SN55325J	55325F
SN55450BJ	55450BF
SN55450BN	55450BN
SN55451BJG	55451BFE
SN55451BL	55451BT
SN55452BJG	55452BFE
SN55452BL	55452BT
SN55453BJG	55453BFE
SN55453BL	55453BT
SN55454BJG	55454BFE
SN55454BL	55454BT
SN72301AJ	LM301AF
SN72301AL	LM301AT
SN72301AN	LM301AN-14
SN72301AP	LM301AN
SN72307J	LM307F
SN72307L	LM307T
SN72307N	LM307N-14
SN72307P	LM307N
SN72308AJ	LM308AF
SN72308AL	LM308AT
SN72308AP	LM308AN
SN72308J	LM308F
SN72308L	LM308T
SN72308P	LM308N
SN72309LA	LM309DB
SN72311J	LM311F
SN72311L	LM311T
SN72311N	LM311N-14
SN72311P	LM311N
SN72555L	NE555T
SN72555P	NE555N
SN72558L	MC1458T
SN72558P	MC1458N
SN72709J	μA709CF
SN72709L	μA709CT
SN72709N	μA709CN-14
SN72709P	μA709CN
SN72710J	μA710CF
SN72710L	μA710CT
SN72710N	μA710CN-14
SN72710P	μA710CN
SN72711J	μA711CF
SN72711L	μA711CT
SN72711N	μA711CN
SN72723J	μA723CF
SN72723L	μA723CT
SN72723N	μA723CN
SN72733J	μA733CF
SN72733L	μA733CT
SN72733N	μA733CN
SN72741J	μA741CF
SN72741L	μA741CT
SN72741N	μA741CN-14
SN72741P	μA741CN
SN72747J	μA747CF
SN72747L	μA747CT
SN72747N	μA747CN
SN72748J	μA748CF
SN72748L	μA748CT
SN72748N	μA748CN-14
SN72748P	μA748CN
SN72771J	MC1456F
SN72771N	MC1456N
SN72771T	MC1456T
SN75107AT	75S107F
SN75107AN	75S107N
SN75108AT	75S108F
SN75108AN	75S108N
SN75182J	DS8820F
SN75182N	DS8820N
SN75183J	DS8830F
SN75183N	DS8830N
SN75188J	MC1488F
SN75188N	MC1488N
SN75189AT	MC1489AF
SN75189AN	MC1489AN
SN75189J	MC1489F
SN75189N	MC1489N
SN75207J	75S207F
SN75207N	75S207N
SN75208J	75S208F
SN75208N	75S208N
SN75324J	75324F
SN75324N	75324N
SN75450BJ	75450BF
SN75451BJG	75452BFE
SN75451BL	75451BT
SN75450BN	75450BN
SN75451BP	75451BN

type to be replaced	replacement
SN75452BJG	75452BFE
SN75452BL	75452BT
SN75452BP	75452BN
SN75453BJG	75453BFE
SN75453BL	75453BT
SN75453BP	75453BN
SN75454JG	75454FE
SN75454L	75454T
SN75454P	75454N
SN75466J	NE5501F
SN75466N	NE5501N
SN75467J	NE5502F
SN75467N	NE5502N
SN75468J	NE5503F
SN75468N	NE5503N
SN75469J	NE5504F
SN75469N	NE5504N
TBB0747	μA747CK
TBB0748	μA748CT
TBB0748B	μA748CN
TBB1458	MC1458T
TBB1458B	MC1458N
TBC0747	μA747K
TBC1458	MC1558T
TDB0555	NE555T
TDB0555B	NE555N
TDB0556A	NE556N
TDB0723	μA723CK
TDB0723A	μA723CN
TDB7805	7805CDN
TDB7805T	7805CU
TDB7806	7806CDA
TDB7806T	7806CU
TDB7808	7808CDA
TDB7808T	7808CU
TDB7812	7812CDA
TDB7812T	7812CU
TDB7815	7815CDA
TDB7815T	7815CU
TDB7818	7818CDA
TDB7818T	7818CU
TDB7824	7824CDA
TDB7824T	7824CU
TDC0555	SE555T
TDC0723	μA723K
TL430JG	TL430FE
TL430LP	TL430S
UDN5711M	UDN5711N
UDN5712M	UDN5712N
UDN5713M	UDN5713N
UDN5714M	UDN5714N
ULN2001A	ULN2001N
ULN2002A	ULN2002N
ULN2003A	ULN2003N
ULN2004A	ULN2004N
556CJ	NE556CN
709AE	μA709AT
709AL	μA709AF
709BE	μA709T
709BL	μA709F
709CE	μA709CT
709CJ	μA709CN-14
709CL	μA709CF
710BE	μA710T
710BL	μA710F
710CE	μA710CT
710CL	μA710CF
711BE	μA711T
711BL	μA711F
711CE	μA711CT
711CJ	μA711CN
711CL	μA711CF
723BE	μA723T
723CE	μA723CT
723CT	μA723CN
723CL	μA723CF
733BE	μA733T
733CE	μA733CT
733CJ	μA733CN
741BE	μA741T
741BL	μA741F
741CE	μA741CT
741CJ	μA741CN-14
741CP	μA741CN
747BE	μA747T
747BL	μA747F
747CE	μA747CT
747CJ	μA747CN
747CL	μA747CF
748BE	μA748T
748BL	μA748F
748CE	μA748CT
748CL	μA748CF
748CP	μA748CN-14
1458CE	MC1458T
1458CP	MC1458N
1458E	MC1458T
1458P	MC1458N
1558E	MC1558T
2740CE	μA740CT
7524DC	7524F
7524PC	7524N
7525DC	7525F
7525PC	7525N
7528DC	7528F
7528PC	7528N
9665DC	ULN2001F
9665PC	ULN2001N
9666DC	ULN2002F
9666PC	ULN2002N
9667DC	ULN2003F
9667PC	ULN2003N
55325DM	55325F
55450BDM	55450BF
55451BHM	55451BT
55451BRM	55451BFE
55452BHM	55452BT
55452BRM	55452BFE
55453BHM	55453BT
55453BRM	55453BFE
55454BHM	55454BT
55454BRM	55454BFE
75107ADC	75S107F
75107APC	75S107N
75108ADC	75S108F
75108APC	75S108N
75207DM	75S207F
75207PC	75S207N
75208DM	75S208F
75208PC	75S208N
75325DC	75325F
75325PC	75325N
75450BDC	75450BF
75450BPC	75450BN
75451BDC	75451BF
75451BHC	75451BT
75451BRC	75451BFE
75451BTC	75451BN
75452BHC	75452BT
75452BRC	75452BFE
75452BTC	75452BN
75453BHC	75453BT
75453BRC	75453BFE
75453BTC	75453BN
75454BHC	75454BT
75454BRC	75454BFE
75454BTC	75454BN

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Single op amps

device no.	temp. range	max input voltage		max input current		min	typ BW	typ	typical common mode	
		offset mV	drift µV/°C	offset nA	bias nA	A_{VOL} V/mV	$A_V = 1$ MHz	slew rate V/µs	rej. ratio dB	volt. range V
LF155	military	7,00	5,0 ●	20	50	25	2,5	5,0	100	± 12
LF255	industrial	6,50	5,0 ●	1,0	5,0	25	2,5	5,0	100	± 12
LF355	commercial	13,0	5,0 ●	2,0	8,0	15	2,5	5,0	100	± 12
LF156	military	7,00	5,0 ●	20	50	25	5,0	12,0	100	± 12
LF256	industrial	6,50	5,0 ●	1,0	5,0	25	5,0	12,0	100	± 12
LF356	commercial	13,0	5,0 ●	2,0	8,0	15	5,0	12,0	100	± 12
LF157	military	7,00	5,0 ●	20	50	25	20	50,0	100	± 12
LF257	industrial	6,50	5,0 ●	1,0	5,0	25	20	50,0	100	± 12
LF357	commercial	13,0	5,0 ●	2,0	8,0	15	20	50,0	100	± 12
LF155A	military	2,50	5,0	10	25	25	2,5	5,0	100	± 12
LF355A	commercial	2,30	5,0	1,0	5,0	15	2,5	5,0	100	± 12
LF156A	military	2,50	5,0	10	25	25	5,0	12,0	100	± 12
LF356A	commercial	2,30	5,0	1,0	5,0	15	5,0	12,0	100	± 12
LF157A	military	2,50	5,0	10,0	25	25	20	50,0	100	± 12
LF357A	commercial	2,30	5,0	1,0	5,0	15	20	50,0	100	± 12
LM101	military	6,00	3,0 ■	500	1500	25	1,0	0,5	90	± 12
LM201	industrial	10,0	6,0 ■	750	2000	15	1,0	0,5	90	± 12
LM101A	military	3,00	15	20	100	25	1,0	0,5	96	± 15
LM201A	industrial	3,00	15	20	100	25	1,0	0,5	96	± 15
LM301A	commercial	10,0	30	70	300	15	1,0	0,5	90	± 12
LM107	military	3,00	15	20	100	25	1,0	0,5	96	± 15
LM207	industrial	3,00	15	20	100	25	1,0	0,5	96	± 15
LM307	commercial	10,0	30	70	300	15	1,0	0,5	90	± 12
LM108	military	3,00	15	0,4	3,0	25	1,0	0,3	100	± 13,5
LM208	industrial	3,00	15	0,4	3,0	25	1,0	0,3	100	± 13,5
LM308	commercial	10,0	30	1,5	10,0	15	1,0	0,3	100	± 14
LM108A	military	1,00	5,0	0,4	3,0	40	1,0	0,3	110	± 13,5
LM208A	industrial	1,00	5,0	0,4	3,0	40	1,0	0,3	110	± 13,5
LM308A	commercial	0,75	5,0	1,5	10,0	60	1,0	0,3	110	± 14
MC1456	commercial	14,0	—	14,0	40	40	1,0	2,5	110	± 12
MC1556	military	6,00	—	5,0	30	40	1,0	2,5	110	± 13
NE530	commercial	6,00	6,0 ●	80	200	15	3,0	35	90	± 13
SE530	military	3,00	15	20	100	25	3,0	35	90	± 13
NE531	commercial	7,50	—	300	2000	15	1,0	35	90	± 11
SE531	military	6,00	—	500	1500	25	1,0	35	90	± 11
NE535	commercial	6,00	6,0 ●	80	200	15	1,0	15	90	± 13
SE535	military	3,00	15	20	100	25	1,0	15	90	± 13

Specifications guaranteed over full temperature range unless otherwise indicated by following marks:

- ● typical over full temperature range
- ▲ guaranteed at 25 °C
- ■ typical at 25 °C

diff. input voltage V	typ PSRR dB	supply voltage typ min V	max V	output current mA	max supply current mA	min output volt. swing V	internal compensation	packages	page no.
± 40	100	± 3	± 22	—	4,0	± 12	yes	T	B26
± 40	100	± 3	± 22	—	4,0	± 12	yes	T	
± 30	100	± 3	± 18	—	4,0	± 12	yes	T	
± 40	100	± 3	± 22	—	7,0	± 12	yes	T	B26
± 40	100	± 3	± 22	—	7,0	± 12	yes	T	
± 30	100	± 3	± 18	—	10,0	± 12	yes	T	
± 40	100	± 3	± 22	—	7,0	± 12	yes	T	B26
± 40	100	± 3	± 22	—	7,0	± 12	yes	T	
± 30	100	± 3	± 18	—	10,0	± 12	yes	T	
± 40	100	± 3	± 22	—	4,0	± 12	yes	T	B26
± 30	100	± 3	± 18	—	4,0	± 12	yes	T	
± 40	100	± 3	± 22	—	7,0	± 12	yes	T	B27
± 30	100	± 3	± 18	—	10,0	± 12	yes	T	
± 40	100	± 3	± 22	—	7,0	± 12	yes	T	B27
± 30	100	± 3	± 18	—	10,0	± 12	yes	T	
± 30	90	± 3	± 22	5,0	2,5	± 12	no	F,FE,N,N-14,T	B28
± 30	90	± 3	± 22	5,0	3,0 ▲	± 12	no	F,FE,N,N-14,T	
± 30	96	± 3	± 22	7,5	2,5	± 12	no	F,FE,N,N-14,T	B29
± 30	96	± 3	± 22	5,0	2,5	± 12	no	F,FE,N,N-14,T	
± 30	96	± 3	± 18	5,0	3,0 ▲	± 12	no	F,FE,N,N-14,T	
± 30	96	± 3	± 22	7,5	2,5	± 12	yes	F,FE,N,T	B29
± 30	96	± 3	± 22	5,0	2,5	± 12	yes	F,FE,N,T	
± 30	96	± 3	± 18	5,0	3.0 ▲	± 12	yes	F,FE,N,T	
—	96	± 2	± 20	1,0	0,4	± 13	no	F,FE,N,T	B30
—	96	± 2	± 20	1,0	0,4	± 13	no	F,FE,N,T	
—	96	± 2	± 18	1,0	0,8 ▲	± 13	no	F,FE,N,T	
—	110	± 2	± 20	1,0	0,4	± 13	no	F,FE,T	B30
—	110	± 2	± 20	1,0	0,4	± 13	no	F,FE,T	
—	110	± 2	± 18	1,0	0,8 ▲	± 13	no	F,FE,N,T	
± 18	86	± 3	± 18	20	3,0 ▲	± 11	yes	F,N,T	B34
± 22	86	± 3	± 22	20	1,5 ▲	± 12	yes	F,N,T	
± 30	110	± 3	± 18	5,0	3,0	± 12	yes	FE,N,T	B35
± 30	110	± 3	± 22	5,0	3,0	± 12	yes	FE,N,T	
± 15	100	± 5	± 22	5,0	10 ▲	± 10	no	N,T	B36
± 15	100	± 5	± 22	5,0	7,0 ▲	± 10	no	T	
± 30	110	± 3	± 18	5,0	3,0	± 12	yes	FE,N,T	B37
± 30	110	± 3	± 22	5,0	3,0	± 12	yes	FE,N,T	

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For low noise specifications of very low noise op amps **NE/SE5534** and **TDA1034** see page **B41**.

Single op amps

device no.	temp. range	max input voltage offset mV	max input voltage drift μV/°C	max input current offset nA	max input current bias nA	min A_{VOL} V/mV	typ BW $A_V = 1$ MHz	typ slew rate V/μs	typical common mode rej. ratio dB	typical common mode volt. range V
NE536	commercial	30 ●	30 ●	5 pA ■	0,1 ▲	25	1,0	6,0	80	± 11
SU536	military	30	20 ●	5 pA ■	3,0	50	1,0	6,0	80	± 11
NE538	commercial	6,0	6,0 ●	80	200	25	6,0	60	90	± 13
SE538	military	3,0	15	20	100	25	6,0	60	90	± 13
NE5534	commercial	5,0	–	400	2000	15	10	13	100	± 13
SE5534	military	3,0	–	500	1500	25	10	13	100	± 13
TDA1034	industrial	5,0	–	500	2000	15	10	13	100	± 13
μA709	military	6,0	6,0 ●	500	1500	25	1,0	0,3	90	± 10
μA709A	military	3,0	25	250	600	25	1,0	0,3	110	± 10
μA709C	commercial	10,0	12,0 ●	750	1500	12	1,0	0,3	90	± 10
SA709C	ext. ind.	10,0	12,0 ●	750	1500	12	1,0	0,3	90	± 10
μA740C	commercial	30 ●	–	0,06 ●	10,0	500 ●	1,0	6,0	80	± 12
μA741	military	6,0	–	500	1500	25	1,0	0,5	90	± 13
μA741C	commercial	7,5	–	300	800	15	1,0	0,5	90	± 13
SA741C	ext. ind.	6,0	–	500	1500	15	1,0	0,5	90	± 13
μA748	military	6,0	–	500	1500	25	1,0	0,5	90	± 13
μA748C	commercial	7,5	–	300	800	25	1,0	0,5	90	± 13
SA748C	ext. ind.	7,5	–	500	1500	25	1,0	0,5	90	± 13
TCA520	commercial	6,0 ▲	5,0 ●	30 ▲	100 ▲	–	1,0 ▲	0,3 ▲	100 ▲	± 11 ▲
TDA0301	commercial	–	–	–	–	–	–	–	–	–
TDA0741	commercial	7,5	–	300	800	15	1,0	0,5	90	± 13
TDA0748	commercial	6 ▲	–	200 ▲	500 ▲	15	1,0	0,5	90	± 13
TDA1078 **NE5539**	commercial	5,0 ▲	–	–	–	–	2,0	800 ■	85 ■	–

Specifications guaranteed over full temperature range unless otherwise indicated by following marks:

- ● typical over full temperature range
- ▲ guaranteed at 25 °C
- ■ typical at 25 °C

diff. input voltage V	typ PSRR dB	supply voltage		output current mA	max supply current mA	min output volt. swing V	internal compen-sation	packages	page no.
		typ min V	max V						
± 30	80	± 6	± 20	5,0	8,0 ▲	± 12	yes	T	B37
± 30	86	± 6	± 18	5,0	5,5 ▲	± 12	yes	T	
± 30	110	± 3	± 18	5,0	3,0	± 12	yes	FE,N,T	B37
± 30	110	± 3	± 22	5,0	3,0	± 12	yes	FE,N,T	
± 30	100	± 3	± 20	10	8,0	± 12	yes	FE,N,T	B41
± 30	100	± 3	± 20	10	6,5	± 12	yes	FE,N,T	
± 30	100	± 3	± 20	10	8,0	± 12	yes	FE,N,T	B41
± 5	92	± 9	± 18	5,0	5,5 ▲	± 12	no	F,N,N-14,T	B32
± 5	92	± 9	± 18	5,0	5,5 ▲	± 12	no	F,N,N-14,T	
± 5	92	± 9	± 18	5,0	6,6 ▲	± 12	no	F,N,N-14,T	
± 5	92	± 9	± 18	5,0	6,6 ▲	± 12	no	F,FE,N,N-14	B32
± 30	80	± 5	± 22	5,0	8,0 ▲	± 12	yes	T	B32
± 30	100	± 3	± 22	5,0	2,5	± 12	yes	F,FE,N,N-14,T	B33
± 30	100	± 3	± 18	5,0	2,8 ▲	± 12	yes	F,FE,N,N-14,T	
± 30	100	± 3	± 18	5,0	2,8 ▲	± 12	yes	F,FE,N,N-14,T	B33
± 30	90	± 3	± 22	5,0	2,8	± 12	no	F,FE,N,N-14,T	B34
± 30	90	± 3	± 18	5,0	2,8	± 12	no	F,FE,N,N-14,T	
± 30	90	± 3	± 18	5,0	2,8	± 12	no	F,FE,N,N-14,T	B34
± 6 ▲	–	2	22	12,0 ▲	1,5 ■	–	no	FE, N, SO-8	B39
–	–	–	–	–	–	–	–	SO-8	B40
± 30	100	± 3	± 18	5,0	2,8 ▲	± 12	yes	SO-8	B40
± 30	100	± 3	± 18	5,0	2,8 ▲	± 12	yes	SO-8	B41
–	–	± 8	± 12	40 ■	15 ■	–	no	N-14	B42

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For low noise specifications of very low noise op amps **NE/SE5533** see page B38.

Dual op amps

device no.	temp. range	max input voltage		max input current		min	typ BW	typ	typical common mode	
		offset mV	drift µV/°C	offset nA	bias nA	A_{VOL} V/mV	$A_V = 1$ MHz	slew rate V/µs	rej. ratio dB	volt. range V
LH2101A	military	3,0	15	20	100	25	1,0	0,5	96	± 15
LH2201A	industrial	3,0	15	20	100	25	1,0	0,5	96	± 15
LH2301A	commercial	10,0	30	70	300	15	1,0	0,5	90	± 12
LH2108	military	3,0	15	0,4	3,0	25	1,0	0,3	100	± 13,5
LH2208	industrial	3,0	15	0,4	3,0	25	1,0	0,3	100	± 13,5
LH2308	commercial	10,0	30	1,5	10,0	15	1,0	0,3	100	± 14
LH2108A	military	1,0	5,0	0,4	3,0	40	1,0	0,3	110	± 13,5
LH2208A	industrial	1,0	5,0	0,4	3,0	40	1,0	0,3	110	± 13,5
LH2308A	commercial	0,75	5,0	1,5	10,0	60	1,0	0,3	110	± 14
LM158	military	7,0	7,0 ●	100	300	25	1,0	–	85	V_S–1,5
LM258	industrial	9,0	7,0 ●	150	500	25	1,0	–	85	V_S–1,5
LM358	commercial	9,0	7,0 ●	150	500	15	1,0	–	85	V_S–1,5
LM158A	military	4,0	15,0	30	100	25	1,0	–	85	V_S–1,5
LM258A	industrial	4,0	15,0	30	100	25	1,0	–	85	V_S–1,5
LM358A	commercial	5,0	20,0	75	200	15	1,0	–	85	V_S–1,5
MC1458	commercial	7,5	–	300	800	15	1,0	0,8	90	± 13
MC1558	military	6,0	–	500	1500	25	1,0	0,5	90	± 13
SA1458	ext. ind.	7,5	–	500	1500	15	1,0	0,5	90	± 13
NE532	commercial	7,5	7,0 ●	150	500	15	1,0	–	85	V_S–1,5
SA532	ext. ind.	7,5	7,5 ●	150	500	15	1,0	–	85	V_S–1,5
SE532	military	7,0	7,0 ●	100	300	25	1,0	–	85	V_S–1,5
NE532A	commercial	5,0	20	75	200	15	1,0	–	85	V_S–1,5
SE532A	military	4,0	15	30	100	25	1,0	–	85	V_S–1,5
NE5530	commercial	6,0	6,0 ●	80	200	15	3,0	35	90	± 13
SE5530	military	3,0	15	20	100	25	3,0	35	90	± 13
NE5533	commercial	5,0	–	400	2000	15	10	13	100	± 13
SE5533	military	3,0	–	500	1500	25	10	13	100	± 13
NE5535	commercial	6,0	6,0 ●	80	200	15	1,0	15	90	± 13
SE5535	military	3,0	15	20	100	25	1,0	15	90	± 13
NE5538	commercial	6,0	6,0 ●	80	200	25	6,0	60	90	± 13
SE5538	military	3,0	15	20	100	25	6,0	60	90	± 13
µA747	military	6,0	–	500	1500	25	1,0	0,5	90	± 13
µA747C	commercial	7,5	–	300	800	15	1,0	0,5	90	± 13
SA747C	ext. ind.	7,5	–	500	1500	15	1,0	0,5	90	± 13
TDA0358	commercial	5,0	20	75	200	15	1,0	–	85	V_S–1,5
TDA1458	commercial	7,5	–	300	800	15	1,0	0,5	90	± 13

Specifications guaranteed over full temperature range unless otherwise indicated by following marks:

- ● typical over full temperature range
- ▲ guaranteed at 25 °C
- ■ typical at 25 °C

diff. input voltage V	typ PSRR dB	supply voltage typ min V	max V	output current mA	max supply current mA	min output volt. swing V	internal compensation	packages	page no.
± 30	96	± 3	± 22	7,5	2,5	± 12	no	F	B27
± 30	96	± 3	± 22	5,0	2,5	± 12	no	F	
± 30	96	± 3	± 18	5,0	3,0 ▲	± 12	no	F	
—	96	± 2	± 20	1,0	0,4	± 13	no	F	B28
—	96	± 2	± 20	1,0	0,4	± 13	no	F	
—	96	± 2	± 18	1,0	0,8 ▲	± 13	no	F	
—	110	± 2	± 20	1,0	0,4	± 13	no	F	B28
—	110	± 2	± 20	1,0	0,4	± 13	no	F	
—	110	± 2	± 18	1,0	0,8 ▲	± 13	no	F	
32	100	3	30	40	2,0	V_S-2	yes	FE,N,T	B31
32	100	3	30	40	2,0	V_S-2	yes	FE,N,T	
32	100	3	30	40	2,0	V_S-2	yes	FE,N,T	
32	100	3	30	40	2,0	V_S-2	yes	FE,N,T	B31
32	100	3	30	40	2,0	V_S-2	yes	FE,N,T	
32	100	3	30	40	2,0	V_S-2	yes	FE,N,T	
± 30	90	± 3	± 18	5,0	5,6 ▲	± 12	yes	F,FE,N,N-14,T	B35
± 30	90	± 3	± 22	5,0	5,0 ▲	± 12	yes	F,FE,N,N-14,T	
± 30	90	± 3	± 22	5,0	5,6 ▲	± 12	yes	F,FE,N,N-14,T	
32	100	3	30	40	1,2	V_S-2	yes	FE,N,T	B36
32	100	3	30	40	1,2	V_S-2	yes	FE,N,T	
32	100	3	30	40	1,2	V_S-2	yes	FE,N,T	
32	100	3	30	40	1,2	V_S-2	yes	FE,N,T	B36
32	100	3	30	40	1,2	V_S-2	yes	FE,N,T	
± 30	110	± 3	± 18	5,0	3,0	± 12	yes	FE,N,T	B38
± 30	110	± 3	± 22	5,0	3,0	± 12	yes	FE,N,T	
± 30	100	± 3	± 20	10	8,0	± 12	yes	F,FE,N,N-14,T	B38
± 30	100	± 3	± 20	10	6,5	± 12	yes	F,FE,N,N-14,T	
± 30	110	± 3	± 18	5,0	3,0	± 12	yes	F,FE,N,N-14,T	B38
± 30	110	± 3	± 22	5,0	3,0	± 12	yes	F,FE,N,N-14,T	
± 30	110	± 3	± 18	5,0	—	± 12	yes	F,FE,N,N-14,T	B39
± 30	110	± 3	± 22	5,0	—	± 12	yes	F,FE,N,N-14,T	
± 30	90	± 3	± 22	5,0	3,3	± 12	yes	F,K,N-14	B33
± 30	90	± 3	± 18	5,0	3,3	± 12	yes	F,K,N-14	
± 30	90	± 3	± 18	5,0	3,3	± 12	yes	F,K,N-14	B33
32	100	3	30	40	2,0	V_S-2	yes	SO-8	B40
± 30	100	± 3	± 18	5,0	2,8 ▲	± 12	yes	SO-8	B42

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Triple op amps

device no.	temp. range	max input voltage offset mV	max input voltage drift µV/°C	max input current offset nA	max input current bias nA	min A_{VOL} V/mV	typ BW $A_V = 1$ MHz	typ slew rate V/µs	typical common mode rej. ratio dB	typical common mode volt. range V
TCA220	commercial	10,0 ▲	–	200 ▲	2000 ▲	4,0 ■	5,0	0,4	90	18

Quadruple op amps

device no.	temp. range	max input voltage offset mV	max input voltage drift µV/°C	max input current offset nA	max input current bias nA	min A_{VOL} V/mV	typ BW $A_V = 1$ MHz	typ slew rate V/µs	typical common mode rej. ratio dB	typical common mode volt. range V
LM124	military	7,0	7,0 ●	100	300	25	1,0	–	85	V_S–1,5
LM224	industrial	9,0	7,0 ●	150	500	15	1,0	–	85	V_S–1,5
LM324	commercial	9,0	7,0 ●	150	500	15	1,0	–	85	V_S–1,5
SA534	ext. ind.	9,0	7,0 ●	150	500	15	1,0	–	85	V_S–1,5
LM2902	ext. ind.	15,0	7,0 ●	200	1000	15	1,0	–	85	V_S–1,5
LM124A	military	4,0	20	30	100	25	1,0	–	85	V_S–1,5
LM224A	industrial	4,0	20	30	100	25	1,0	–	85	V_S–1,5
LM324A	commercial	5,0	30	75	200	15	1,0	–	85	V_S–1,5
TDA0324	commercial	9,0	7,0 ●	150	500	15	1,0	–	85	V_S–1,5

Specifications guaranteed over full temperature range unless otherwise indicated by following marks:

- ● typical over full temperature range
- ▲ guaranteed at 25 °C
- ■ typical at 25 °C

diff. input voltage V	typ PSRR dB	supply voltage		output current mA	max supply current mA	min output volt. swing V	internal compen-sation	packages	page no.
		typ min V	max V						
5,0	66	–	18	100	1,0 ■	5	no	N-16	B39
32	100	3	30	40	2,0	V_S-2	yes	F,N-14	B30
32	100	3	30	40	2,0	V_S-2	yes	F,N-14	
32	100	3	30	40	2,0	V_S-2	yes	F,N-14	
32	100	3	30	40	2,0	V_S-2	yes	F,N-14	B30
26	100	3	26	40	2,0	V_S-2	yes	N-14	B30
32	100	3	30	40	2,0	V_S-2	yes	F,N-14	B31
32	100	3	30	40	2,0	V_S-2	yes	F,N-14	
32	100	3	30	40	2,0	V_S-2	yes	F,N-14	
32	100	3	30	40	2,0	V_S-2	yes	SO-14	B40

operational amplifiers

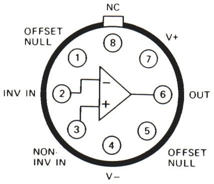
abridged data

J-FET input op amp LF155/255/355

Temperature range:

Military	−55 °C to 125 °C	LF155T
Industrial	−25 °C to 85 °C	LF255T
Commercial	0 °C to 70 °C	LF355T

- Low supply current 4 mA(max)
- Input offset voltage 3 mV(typ)
- Input offset current 3 pA(typ)
- Input offset voltage drift 5 µV/ °C(typ)


NC
OFFSET NULL
V+
8
1
7
INV IN
2
−
6
OUT
+
3
5
4
NON-INV IN
OFFSET NULL
V−

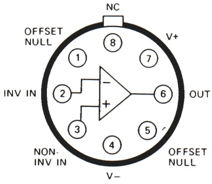
Package T

J-FET input op amp LF156/256/356

Temperature range:

Military	−55 °C to 125 °C	LF156T
Industrial	−25 °C to 85 °C	LF256T
Commercial	0 °C to 70 °C	LF356T

- Fast slew rate 7,5 V/µs(min)
- Input noise voltage 12 nV/$\sqrt{Hz}$(typ)
- Input offset voltage 3 mV(typ)
- Input offset current 3 pA(typ)
- Input offset voltage drift 5 µV/ °C(typ)


NC
OFFSET NULL
V+
8
1
7
INV IN
2
−
6
OUT
+
3
5
4
NON-INV IN
OFFSET NULL
V−

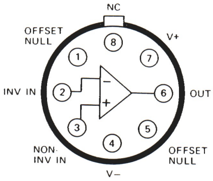
Package T

J-FET input op amp LF155A/355A

Temperature range:

Military	−55 °C to 125 °C	LF155AT
Commercial	0 °C to 70 °C	LF355AT

- Low supply current 4 mA(max)
- Input offset voltage 1 mV(typ)
- Input offset current 3 pA(typ)
- Input offset voltage drift 5 µV/ °C(max)


NC
OFFSET NULL
V+
8
1
7
INV IN
2
−
6
OUT
+
3
5
4
NON-INV IN
OFFSET NULL
V−

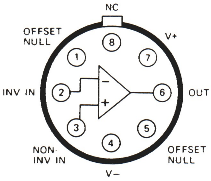
Package T

J-FET input op amp LF157/257/357

Temperature range:

Military	−55 °C to 125 °C	LF157T
Industrial	−25 °C to 85 °C	LF257T
Commercial	0 °C to 70 °C	LF357T

- Extra fast slew rate 30 V/µs (min)
- Gain bandwidth product 20 MHz
- Input noise voltage 12 nV/$\sqrt{Hz}$ (typ)
- Input offset voltage 3 mV (typ)
- Input offset current 3 pA (typ)
- Input offset voltage drift 5 µV/ °C (typ)


NC
OFFSET NULL
V+
8
1
7
INV IN
2
−
6
OUT
+
3
5
4
NON-INV IN
OFFSET NULL
V−

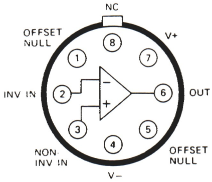
Package T

J-FET input op amp LF156A/356A

Temperature range:

Military	–55 °C to 125 °C	LF156AT
Commercial	0 °C to 70 °C	LF356AT

- Fast slew rate 7,5 V/µs(min)
- Input noise voltage 12 nV/√Hz(typ)
- Input offset voltage 1 mV(typ)
- Input offset current 3 pA(typ)
- Input offset voltage drift 5 µV/ °C(max)


NC
OFFSET NULL
V+
INV IN
OUT
NON-INV IN
OFFSET NULL
V–
1
2
3
4
5
6
7
8
–
+

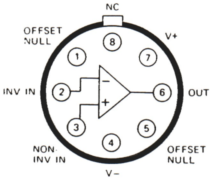
Package T

J-FET input op amp LF157A/357A

Temperature range:

Military	–55 °C to 125 °C	LF157AT
Commercial	0 °C to 70 °C	LF357AT

- Extra fast slew rate 30 V/µs(min)
- Gain bandwidth product 20 MHz
- Input noise voltage 12 nV/√Hz(typ)
- Input offset voltage 1 mV(typ)
- Input offset current 3 pA(typ)
- Input offset voltage drift 5 µV/ °C(max)


NC
OFFSET NULL
V+
INV IN
OUT
NON-INV IN
OFFSET NULL
V–
1
2
3
4
5
6
7
8
–
+

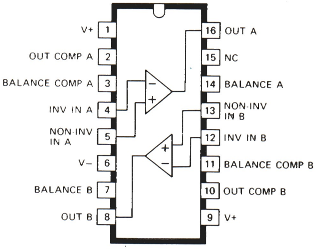
Package T

Dual high performance op amp LH2101A/2201A/2301A

Temperature range:

Military	–55 °C to 125 °C	LH2101AF
Industrial	–25 °C to 85 °C	LH2201AF
Commercial	0 °C to 70 °C	LH2301AF

- Typical gain 160 000
- Input offset current 3,0 nA(typ)
- Input offset voltage 2 mV(typ)


V+ 1
OUT COMP A 2
BALANCE COMP A 3
INV IN A 4
NON-INV IN A 5
V– 6
BALANCE B 7
OUT B 8
16 OUT A
15 NC
14 BALANCE A
13 NON-INV IN B
12 INV IN B
11 BALANCE COMP B
10 OUT COMP B
9 V+
–
+
+
–

Package F

operational amplifiers

abridged data

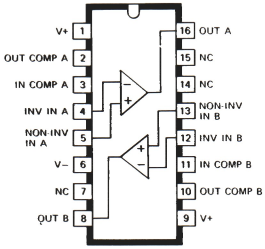
Dual precision op amp

LH2108/2208/2308

Temperature range:

Military	−55 °C to 125 °C	LH2108F
Industrial	−25 °C to 85 °C	LH2208F
Commercial	0 °C to 70 °C	LH2308F

- Super β input transistors
- Typical offset current 0,2 nA
- Typical offset voltage 2 mV
- Typical gain 300 000


V+
OUT COMP A
IN COMP A
INV IN A
NON-INV IN A
V−
NC
OUT B
1
2
3
4
5
6
7
8
16
15
14
13
12
11
10
9
OUT A
NC
NC
NON-INV IN B
INV IN B
IN COMP B
OUT COMP B
V+
−
+
+
−

Package F

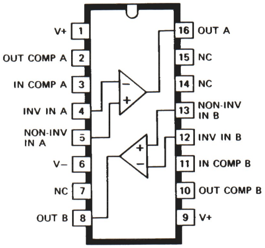
Dual precision op amp

LH2108A/2208A/2308A

Temperature range:

Military	−55 °C to 125 °C	LH2108AF
Industrial	−25 °C to 85 °C	LH2208AF
Commercial	0 °C to 70 °C	LH2308AF

- Super β input transistors
- Typical offset current 0,2 nA
- Typical offset voltage 0,3 mV
- Typical gain 300 000


V+
OUT COMP A
IN COMP A
INV IN A
NON-INV IN A
V−
NC
OUT B
1
2
3
4
5
6
7
8
16
15
14
13
12
11
10
9
OUT A
NC
NC
NON-INV IN B
INV IN B
IN COMP B
OUT COMP B
V+
−
+
+
−

Package F

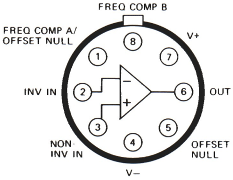
High performance op amp

LM101/201

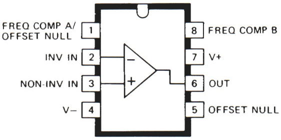
Temperature range:

Military	−55 °C to 125 °C	LM101F, FE, N, T
Commercial	0 °C to 70 °C	LM201F, FE, N, T

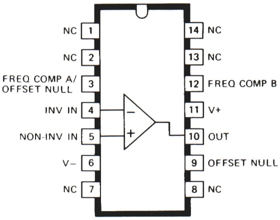
- Typical gain 150 000
- Input offset voltage 2 mV (typ)
- Output short-circuit protection


FREQ COMP B
FREQ COMP A/ OFFSET NULL
V+
INV IN
OUT
NON-INV IN
OFFSET NULL
V−
1
2
3
4
5
6
7
8
−
+

Package T


FREQ COMP A/ OFFSET NULL
INV IN
NON-INV IN
V−
1
2
3
4
8
7
6
5
FREQ COMP B
V+
OUT
OFFSET NULL
−
+

Package FE, N


NC
NC
FREQ COMP A/ OFFSET NULL
INV IN
NON-INV IN
V−
NC
1
2
3
4
5
6
7
14
13
12
11
10
9
8
NC
NC
FREQ COMP B
V+
OUT
OFFSET NULL
NC
−
+

Package F, N-14

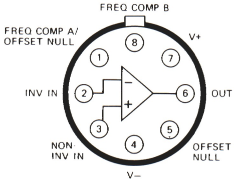
High performance op amp

LM101A/201A/301A

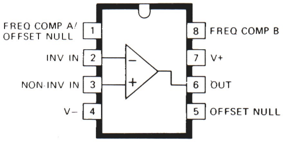
Temperature range:

Military	−55 °C to 125 °C	LM101AF, FE, N, T
Industrial	−25 °C to 85 °C	LM201AF, FE, N, T
Commercial	0 °C to 70 °C	LM301AF, FE, N, T

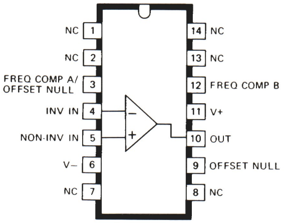
- Typical gain 160 000
- Input offset current, 3,0 nA(typ)
- Input offset voltage, 2 mV(typ)


FREQ COMP B
FREQ COMP A/ OFFSET NULL
V+
INV IN
OUT
NON-INV IN
OFFSET NULL
V−
1
2
3
4
5
6
7
8
−
+

Package T


FREQ COMP A/ OFFSET NULL
INV IN
NON-INV IN
V−
1
2
3
4
8
7
6
5
FREQ COMP B
V+
OUT
OFFSET NULL
−
+

Package FE, N


NC
NC
FREQ COMP A/ OFFSET NULL
INV IN
NON-INV IN
V−
NC
1
2
3
4
5
6
7
14
13
12
11
10
9
8
NC
NC
FREQ COMP B
V+
OUT
OFFSET NULL
NC
−
+

Package F, N-14

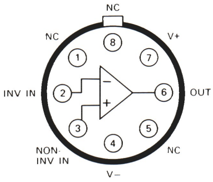
High performance op amp

LM107/207/307

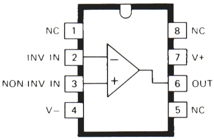
Temperature range:

Military	−55 °C to 125 °C	LM107F, FE, N, T
Industrial	−25 °C to 85 °C	LM207F, FE, N, T
Commercial	0 °C to 70 °C	LM307F, FE, N, T

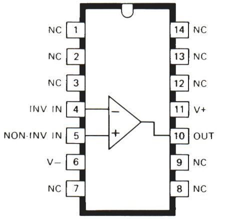
- Internally compensated
- Typical voltage gain 160 000
- Short-circuit protected input and output


NC
NC
V+
INV IN
OUT
NON-INV IN
NC
V−
1
2
3
4
5
6
7
8
−
+

Package T


NC
INV IN
NON-INV IN
V−
1
2
3
4
8
7
6
5
NC
V+
OUT
NC
−
+

Package FE, N


NC
NC
NC
INV IN
NON-INV IN
V−
NC
1
2
3
4
5
6
7
14
13
12
11
10
9
8
NC
NC
NC
V+
OUT
NC
NC
−
+

Package F

operational amplifiers

abridged data

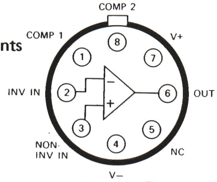
Precision op amp

LM108/208/308

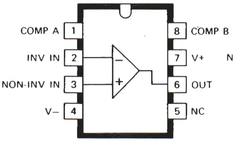
Temperature range:

Military	−55 °C to 125 °C	LM108F, FE, N, T
Industrial	−25 °C to 85 °C	LM208F, FE, N, T
Commercial	0 °C to 70 °C	LM308F, FE, N, T

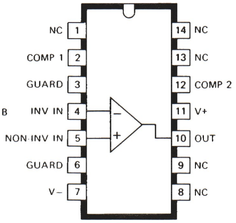
- Super β input transistors
- Low input offset and bias currents typically 0,2 and 1,5 nA
- Offset voltage typically 2 mV
- Typical gain 300 000


COMP 2
COMP 1
V+
INV IN
OUT
NON-INV IN
NC
V−
1
2
3
4
5
6
7
8
−
+

Package T


COMP A 1
INV IN 2
NON-INV IN 3
V− 4
8 COMP B
7 V+
6 OUT
5 NC
−
+

Package FE, N


NC 1
COMP 1 2
GUARD 3
INV IN 4
NON-INV IN 5
GUARD 6
V− 7
14 NC
13 NC
12 COMP 2
11 V+
10 OUT
9 NC
8 NC
−
+

Package F

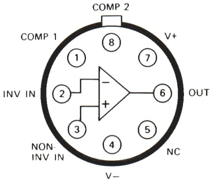
Precision op amp

LM108A/208A/308A

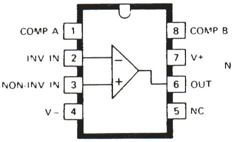
Temperature range:

Military	−55 °C to 125 °C	LM108AF, FE, T
Industrial	−25 °C to 85 °C	LM208AF, FE, T
Commercial	0 °C to 70 °C	LM308AF, FE, N, T

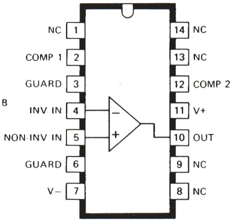
- Super β input transistors
- Typical offset current 0,2 nA
- Typical offset voltage 0,3 mV
- Typical gain 300 000


COMP 2
COMP 1
V+
INV IN
OUT
NON-INV IN
NC
V−
1
2
3
4
5
6
7
8
−
+

Package T


COMP A 1
INV IN 2
NON-INV IN 3
V− 4
8 COMP B
7 V+
6 OUT
5 NC
−
+

Package FE, N


NC 1
COMP 1 2
GUARD 3
INV IN 4
NON-INV IN 5
GUARD 6
V− 7
14 NC
13 NC
12 COMP 2
11 V+
10 OUT
9 NC
8 NC
−
+

Package F

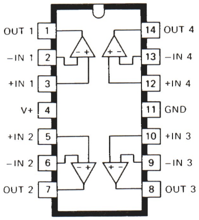
Quad op amp

LM124/224/324/2902
SA534

Temperature range:

Military	−55 °C to 125 °C	LM124F, N
Ext. Ind.	−40 °C to 85 °C	LM2902N/SA534F, N
Industrial	−25 °C to 85 °C	LM224F, N
Commercial	0 °C to 70 °C	LM324F, N

- Internally compensated
- Operation down to 3 volt supply
- Low power supply current 200 μA per amplifier
- Offset voltage 9 mV(max)


OUT 1 1
−IN 1 2
+IN 1 3
V+ 4
+IN 2 5
−IN 2 6
OUT 2 7
14 OUT 4
13 −IN 4
12 +IN 4
11 GND
10 +IN 3
9 −IN 3
8 OUT 3
− +
+ −
− +
+ −

Package F, N-14

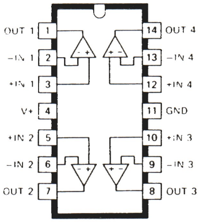
Quad op amp

LM124A/224A/324A

Temperature range:

Military	−55 °C to 125 °C	LM124AF, N
Industrial	−25 °C to 85 °C	LM224AF, N
Commercial	0 °C to 70 °C	LM324AF, N

- Internally compensated
- Operation down to 3 volt supply
- Low power supply current 200 μA per amplifier
- Offset voltage 3 mV(max)


OUT 1
1
−IN 1
2
+IN 1
3
V+
4
+IN 2
5
−IN 2
6
OUT 2
7
14
OUT 4
13
−IN 4
12
+IN 4
11
GND
10
+IN 3
9
−IN 3
8
OUT 3

Package F, N-14

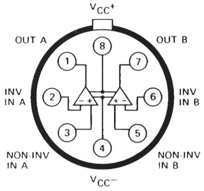
Dual low power op amp

LM158/258/358

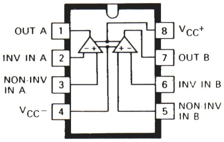
Temperature range:

Military	−55 °C to 125 °C	LM158FE, N, T
Industrial	−25 °C to 85 °C	LM258FE, N, T
Commercial	0 °C to 70 °C	LM358FE, N, T

- Internally compensated
- Operation down to 3 volt supply
- Supply current typically 200 μA per amplifier
- Offset voltage 9 mV(max)


V_{CC}^+
OUT A
OUT B
8
1
7
INV IN A
2
6
INV IN B
3
5
4
NON-INV IN A
NON-INV IN B
V_{CC}^-

Package T


OUT A
1
INV IN A
2
NON-INV IN A
3
V_{CC}^-
4
8
V_{CC}^+
7
OUT B
6
INV IN B
5
NON-INV IN B

Package FE, N

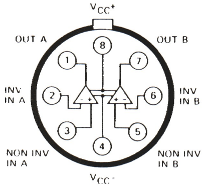
Dual low power op amp

LM158A/258A/358A

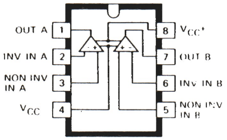
Temperature range:

Military	−55 °C to 125 °C	LM158AFE, N, T
Industrial	−25 °C to 85 °C	LM258AFE, N, T
Commercial	0 °C to 70 °C	LM358AFE, N, T

- Internally compensated
- Operation down to 3 volt supply
- Supply current typically 200 μA per amplifier
- Offset voltage 3 mV(max)


V_{CC}^+
OUT A
OUT B
8
1
7
INV IN A
2
6
INV IN B
3
5
4
NON INV IN A
NON INV IN B
V_{CC}^-

Package T


OUT A
1
INV IN A
2
NON INV IN A
3
V_{CC}
4
8
V_{CC}^+
7
OUT B
6
INV IN B
5
NON INV IN B

Package FE, N

operational amplifiers

abridged data

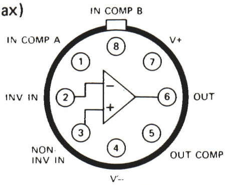
Op amp

µA709A

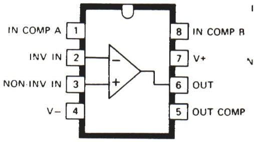
Temperature range:

Military	–55 °C to 125 °C	µA709AF, N, T

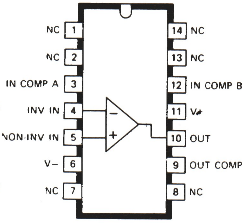
- Open loop gain 45 000 typical
- Input voltage range typ ± 10 V
- Offset voltage 3 mV(max)


IN COMP B
IN COMP A
V+
INV IN
OUT
NON-INV IN
OUT COMP
V–
1
2
3
4
5
6
7
8
–
+

Package T


IN COMP A
INV IN
NON-INV IN
V–
1
2
3
4
8
7
6
5
IN COMP B
V+
OUT
OUT COMP
–
+

Package N


NC
NC
IN COMP A
INV IN
NON-INV IN
V–
NC
1
2
3
4
5
6
7
14
13
12
11
10
9
8
NC
NC
IN COMP B
V+
OUT
OUT COMP
NC
–
+

Package F, N-14

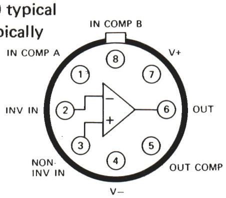
Op amp

µA709/709C
SA709C

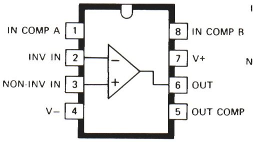
Temperature range:

Military	–55 °C to 125 °C	µA709F, N, T
Ext. Ind.	–40 °C to 85 °C	SA709CF, FE, N
Commercial	0 °C to 70 °C	µA709CF, N, T

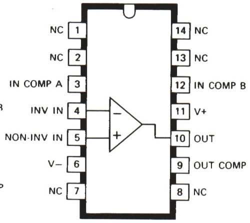
- Open loop gain 45 000 typical
- Input voltage range typically ± 10 Volts


IN COMP B
IN COMP A
V+
INV IN
OUT
NON-INV IN
OUT COMP
V–
1
2
3
4
5
6
7
8
–
+

Package T


IN COMP A
INV IN
NON-INV IN
V–
1
2
3
4
8
7
6
5
IN COMP B
V+
OUT
OUT COMP
–
+

Package FE, N


NC
NC
IN COMP A
INV IN
NON-INV IN
V–
NC
1
2
3
4
5
6
7
14
13
12
11
10
9
8
NC
NC
IN COMP B
V+
OUT
OUT COMP
NC
–
+

Package F, N-14

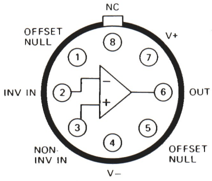
FET input op amp

µA740C

Temperature range:

Commercial	0 °C to 70 °C	µA740CT

- Input bias current typically 100 pA
- Slew rate 6 V/µs
- Input impedance 10^{12} Ω
- Internally compensated


NC
OFFSET NULL
V+
INV IN
OUT
NON-INV IN
OFFSET NULL
V–
1
2
3
4
5
6
7
8
–
+

Package T

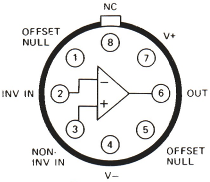
General purpose op amp

μA741/741C
SA741C

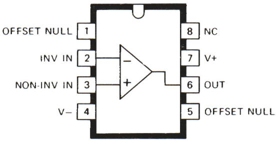
Temperature range:

Military	−55 °C to 125 °C	μA741F, FE, N, T
Ext. Ind.	−40 °C to 85 °C	SA741CF, FE, N, T
Commercial	0 °C to 70 °C	μA741CF, FE, N, T

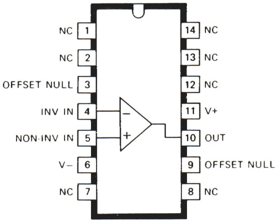
- Typical open loop gain 200 000
- Internal compensation
- Offset null capability
- Output impedance 75 Ω typical


NC
OFFSET NULL
V+
INV IN
OUT
NON-INV IN
OFFSET NULL
V−
1
2
3
4
5
6
7
8
−
+

Package T


OFFSET NULL
INV IN
NON-INV IN
V−
1
2
3
4
8
7
6
5
NC
V+
OUT
OFFSET NULL
−
+

Package FE, N


NC
NC
OFFSET NULL
INV IN
NON-INV IN
V−
NC
1
2
3
4
5
6
7
14
13
12
11
10
9
8
NC
NC
NC
V+
OUT
OFFSET NULL
NC
−
+

Package F, N-14

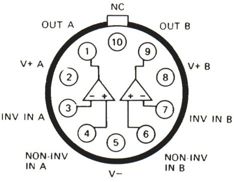
Dual general purpose op amp

μA747/747C
SA747C

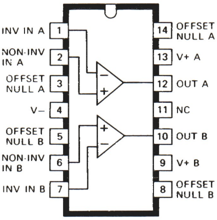
Temperature range:

Military	−55 °C to 125 °C	μA747F, K, N
Ext. Ind.	−40 °C to 85 °C	SA747CF, K, N
Commercial	0 °C to 70 °C	μA747CF, K, N

- Typical open loop gain 200 000
- Internally compensated
- Offset null capability
- Output impedance 75 Ω


NC
OUT A
OUT B
V+ A
V+ B
INV IN A
INV IN B
NON-INV IN A
NON-INV IN B
V−
1
2
3
4
5
6
7
8
9
10
−
+
+
−

Package K


INV IN A
NON-INV IN A
OFFSET NULL A
V−
OFFSET NULL B
NON-INV IN B
INV IN B
1
2
3
4
5
6
7
14
13
12
11
10
9
8
OFFSET NULL A
V+ A
OUT A
NC
OUT B
V+ B
OFFSET NULL B
−
+
+
−

Package F, N-14

operational amplifiers

abridged data

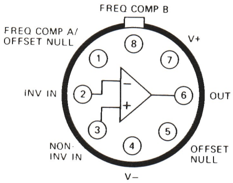
General purpose op amp

μA748/748C
SA748C

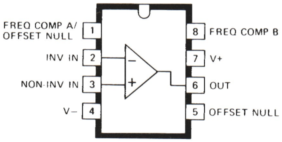
Temperature range:

Military	–55 °C to 125 °C	μA748F, FE, N, T
Ext. Ind.	–40 °C to 85 °C	SA748CF, FE, N, T
Commercial	0 °C to 70 °C	μA748CF, FE, N, T

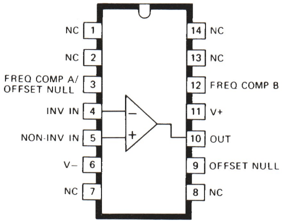
- Typical open loop gain 200 000
- Uncompensated
- Offset null capability
- Output impedance 75 Ω


FREQ COMP B
FREQ COMP A/
OFFSET NULL
V+
8
1
7
INV IN
2
6
OUT
−
+
3
5
4
NON-
INV IN
OFFSET
NULL
V−

Package T


FREQ COMP A/
OFFSET NULL
1
INV IN
2
NON-INV IN
3
V−
4
8
FREQ COMP B
7
V+
6
OUT
5
OFFSET NULL
−
+

Package FE, N


NC
1
NC
2
FREQ COMP A/
OFFSET NULL
3
INV IN
4
NON-INV IN
5
V−
6
NC
7
14
NC
13
NC
12
FREQ COMP B
11
V+
10
OUT
9
OFFSET NULL
8
NC
−
+

Package F, N-14

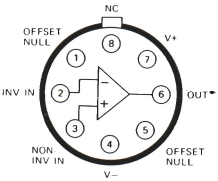
Precision op amp

MC1456/1556

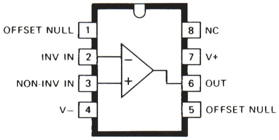
Temperature range:

Military	–55 °C to 125 °C	MC1556F, N, T
Commercial	0 °C to 70 °C	MC1456F, N, T

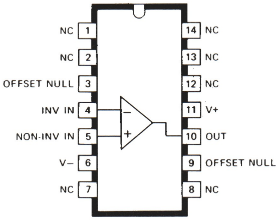
- Super β input transistor
- Low input offset and bias currents, typically 2,0 and 15,0 nA
- 2,5 V/μs slew rate
- Internally compensated


NC
OFFSET
NULL
V+
8
1
7
INV IN
2
6
OUT*
−
+
3
5
4
NON-
INV IN
OFFSET
NULL
V−

Package T


OFFSET NULL
1
INV IN
2
NON-INV IN
3
V−
4
8
NC
7
V+
6
OUT
5
OFFSET NULL
−
+

Package N


NC
1
NC
2
OFFSET NULL
3
INV IN
4
NON-INV IN
5
V−
6
NC
7
14
NC
13
NC
12
NC
11
V+
10
OUT
9
OFFSET NULL
8
NC
−
+

Package F

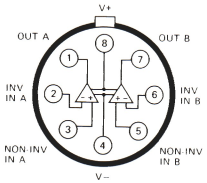
Dual general purpose op amp

MC1458/1558
SA1458

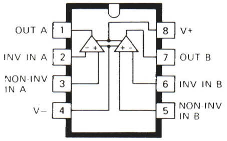
Temperature range:

Military	−55 °C to 125 °C	MC1558F, FE, N, T
Ext. Ind.	−40 °C to 85 °C	SA1458F, FE, N, T
Commercial	0 °C to 70 °C	MC1458F, FE, N, T

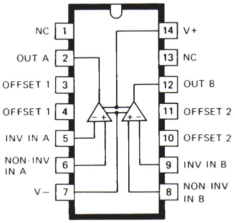
- Typical gain 100 000
- Internally compensated
- Unity gain slew rate 0,8 V/µs


V+
OUT A
OUT B
INV IN A
INV IN B
NON-INV IN A
NON-INV IN B
V−
1
2
3
4
5
6
7
8

Package T


OUT A
INV IN A
NON-INV IN A
V−
V+
OUT B
INV IN B
NON-INV IN B
1
2
3
4
5
6
7
8

Package FE, N


NC
OUT A
OFFSET 1
OFFSET 1
INV IN A
NON-INV IN A
V−
V+
NC
OUT B
OFFSET 2
OFFSET 2
INV IN B
NON-INV IN B
1
2
3
4
5
6
7
8
9
10
11
12
13
14

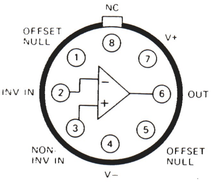
Package F, N-14

High slew rate op amp

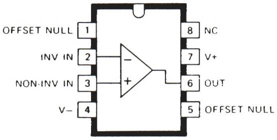
NE/SE530

Temperature range:

Military	−55 °C to 125 °C	SE530FE, N, T
Commercial	0 °C to 70 °C	NE530FE, N, T


NC
OFFSET NULL
V+
INV IN
OUT
NON-INV IN
OFFSET NULL
V−
1
2
3
4
5
6
7
8
−
+

Package T


OFFSET NULL
INV IN
NON-INV IN
V−
NC
V+
OUT
OFFSET NULL
1
2
3
4
5
6
7
8
−
+

Package FE, N

operational amplifiers

abridged data

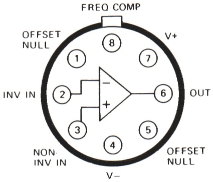
High slew rate op amp

NE/SE531

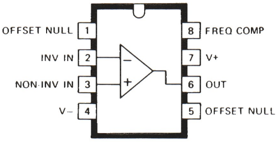
Temperature range:

Military	–55 °C to 125 °C	SE531T
Commercial	0 °C to 70 °C	NE531N, T

- 35 V/µs slew rate at unity gain
- 1 MHz small signal bandwidth
- 500 kHz large signal bandwidth
- Typical open loop gain 100 000
- Pin compatible with µA708, µA748 or LM101
- Compensated with a single capacitor
- Offset null capability


FREQ COMP
OFFSET NULL
V+
8
1
7
INV IN
2
6
OUT
3
5
4
NON-INV IN
OFFSET NULL
V–

Package T


OFFSET NULL
1
INV IN
2
NON-INV IN
3
V–
4
8
FREQ COMP
7
V+
6
OUT
5
OFFSET NULL

Package N

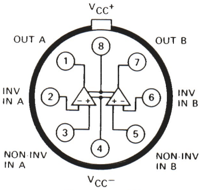
Dual low power op amp

NE/SE532
SA532

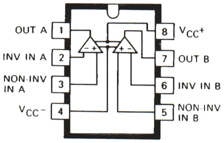
Temperature range:

Military	–55 °C to 125 °C	SE532FE, N, T
Industrial	–25 °C to 85 °C	SA532FE, N, T
Commercial	0 °C to 70 °C	NE532FE, N, T

- Internally compensated
- Operation down to 3 volt supply
- Supply current typically 200 µA per amplifier


V_{CC^+}
OUT A
OUT B
8
1
7
INV IN A
2
6
INV IN B
3
5
4
NON-INV IN A
NON-INV IN B
V_{CC^-}

Package T


OUT A
1
INV IN A
2
NON-INV IN A
3
V_{CC^-}
4
8
V_{CC^+}
7
OUT B
6
INV IN B
5
NON-INV IN B

Package FE, N

Dual low power op amp

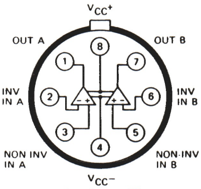
NE/SE532A

Temperature range:

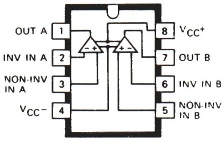
Military	–55 °C to 125 °C	SE532AFE, N, T
Commercial	0 °C to 70 °C	NE532AFE, N, T

Similar to NE/SE532, however

- better offset voltage
- better offset current
- lower input current


V_{CC^+}
OUT A
OUT B
8
1
7
INV IN A
2
6
INV IN B
3
5
4
NON INV IN A
NON-INV IN B
V_{CC^-}

Package T


OUT A
1
INV IN A
2
NON-INV IN A
3
V_{CC^-}
4
8
V_{CC^+}
7
OUT B
6
INV IN B
5
NON-INV IN B

Package FE, N

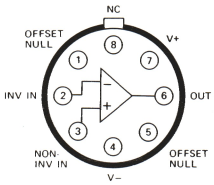
High slew rate op amp

NE/SE535

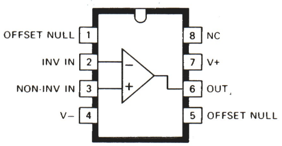
Temperature range:

Military	−55 °C to 125 °C	SE535FE, N, T
Commercial	0 °C to 70 °C	NE535FE, N, T

- 15 V/μs slew rate at unity gain
- Input offset voltage 2 mV (typ)
- Large common mode and differential voltage ranges
- Short-circuit protected


NC
OFFSET NULL
V+
8
1
7
INV IN
2
6
OUT
−
+
3
5
4
NON-INV IN
OFFSET NULL
V−

Package T


OFFSET NULL
1
INV IN
2
NON-INV IN
3
V−
4
8
NC
7
V+
6
OUT
5
OFFSET NULL
−
+

Package FE, N

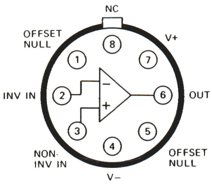
FET input op amp

NE/SU536

Temperature range:

Military	−55 °C to 85 °C	SU536T
Commercial	0 °C to 70 °C	NE536T

- Input bias current 5 pA at 20 °C
- Slew rate 6 V/μs
- Input impedance 10^{14} Ω
- Internally compensated


NC
OFFSET NULL
V+
8
1
7
INV IN
2
6
OUT
−
+
3
5
4
NON-INV IN
OFFSET NULL
V−

Package T

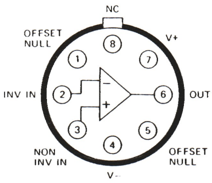
High slew rate op amp

NE/SE538

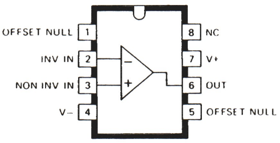
Temperature range:

Military	−55 °C to 125 °C	SE530FE, N, T
Commercial	0 °C to 70 °C	NE538FE, N,T

- 2 mV max input offset voltage
- 60 nA max input offset current
- Short-circuit protected
- 60 V/μs slew rate
- 6 MHz gain bandwidth


NC
OFFSET NULL
V+
8
1
7
INV IN
2
6
OUT
−
+
3
5
4
NON INV IN
OFFSET NULL
V−

Package T


OFFSET NULL
1
INV IN
2
NON INV IN
3
V−
4
8
NC
7
V+
6
OUT
5
OFFSET NULL
−
+

Package FE, N

operational amplifiers

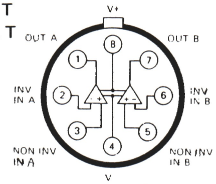
abridged data

Dual high slew rate op amp

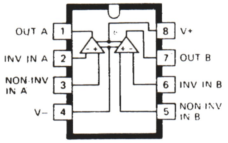
NE/SE5530

Temperature range:

Military	–55 °C to 125 °C	SE5530FE, N, T
Commercial	0 °C to 70 °C	NE5530FE, N, T


V+
OUT A
OUT B
8
1
7
INV IN A
2
6
INV IN B
3
5
4
NON INV IN A
NON INV IN B
V

Package FE, N


OUT A
1
8
V+
INV IN A
2
7
OUT B
NON-INV IN A
3
6
INV IN B
V–
4
5
NON-INV IN B

Package N

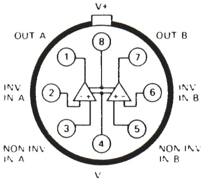
Dual low noise op amp

NE/SE5533

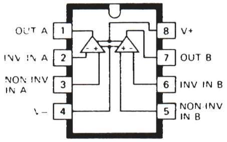
Temperature range:

Military	–55 °C to 125 °C	SE5533F, FE, N, T
Commercial	0 °C to 70 °C	NE5533F, FE, N, T

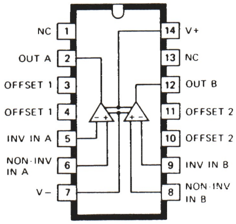
- Small signal bandwidth 10 MHz
- Output drive 10 V(r.m.s.) into 600 Ω
- Input noise 4 nV/$\sqrt{\text{Hz}}$
- Slew rate 13 V/µs


V+
OUT A
OUT B
8
1
7
INV IN A
2
6
INV IN B
3
5
4
NON INV IN A
NON INV IN B
V

Package T


OUT A
1
8
V+
INV IN A
2
7
OUT B
NON INV IN A
3
6
INV IN B
V–
4
5
NON-INV IN B

Package FE, N


NC
1
14
V+
OUT A
2
13
NC
OFFSET 1
3
12
OUT B
OFFSET 1
4
11
OFFSET 2
INV IN A
5
10
OFFSET 2
NON-INV IN A
6
9
INV IN B
V–
7
8
NON-INV IN B

Package F, N-14

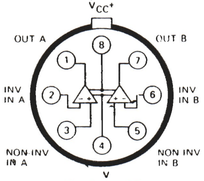
Dual high slew rate op amp

NE/SE5535

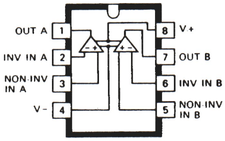
Temperature range:

Military	–55 °C to 125 °C	SE5535F, FE, N, T
Commercial	0 °C to 70 °C	NE5535F, FE, N, T

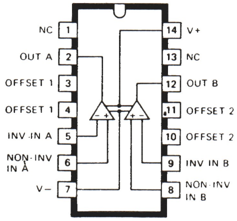
- 15 V/µs slew rate at unity gain
- Input offset voltage 2 mV (typ)
- Large common mode and differential voltage ranges
- Short-circuit protected


V_{CC^+}
OUT A
OUT B
8
1
7
INV IN A
2
6
INV IN B
3
5
4
NON-INV IN A
NON INV IN B
V

Package T


OUT A
1
8
V+
INV IN A
2
7
OUT B
NON-INV IN A
3
6
INV IN B
V–
4
5
NON-INV IN B

Package FE, N


NC
1
14
V+
OUT A
2
13
NC
OFFSET 1
3
12
OUT B
OFFSET 1
4
11
OFFSET 2
INV IN A
5
10
OFFSET 2
NON-INV IN A
6
9
INV IN B
V–
7
8
NON-INV IN B

Package F, N-14

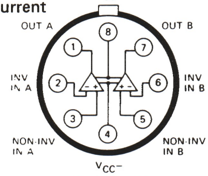
Dual high slew rate op amp

NE/SE5538

Temperature range:

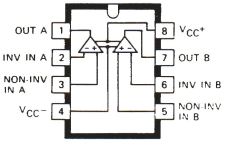
Military	–55 °C to 125 °C	SE5538F, FE, N, T
Commercial	0 °C to 70 °C	NE5538F, FE, N, T

- 2 mV max input offset voltage
- 60 nA max input offset current
- Short-circuit protected
- 60 V/μs slew rate
- 6 MHz gain bandwidth



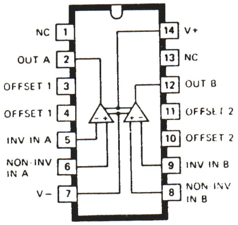
V_{CC}^+
OUT A
OUT B
INV IN A
INV IN B
NON-INV IN A
NON-INV IN B
V_{CC}^-
1
2
3
4
5
6
7
8

Package T



OUT A
INV IN A
NON-INV IN A
V_{CC}^-
V_{CC}^+
OUT B
INV IN B
NON-INV IN B
1
2
3
4
5
6
7
8

Package FE, N



NC
OUT A
OFFSET 1
OFFSET 1
INV IN A
NON-INV IN A
V–
V+
NC
OUT B
OFFSET 2
OFFSET 2
INV IN B
NON-INV IN B
1
2
3
4
5
6
7
8
9
10
11
12
13
14

Package F, N-14

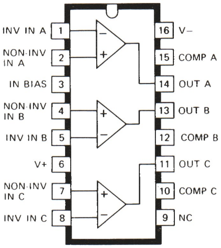
Triple op amp

TCA220

Temperature range:

Commercial	0 °C to 70 °C	TCA220

● Input offset voltage	2 mV(typ)
● Input offset current	200 nA(typ)
● Channel separation	100 dB(typ)
● CMRR	90 dB(typ)



INV IN A
NON-INV IN A
IN BIAS
NON-INV IN B
INV IN B
V+
NON-INV IN C
INV IN C
V–
COMP A
OUT A
OUT B
COMP B
OUT C
COMP C
NC
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16

Package N-16

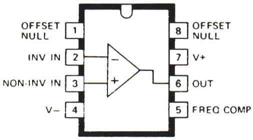
General purpose op amp

TCA520

Temperature range:

Commercial	–25 °C to 70 °C	TCA520B

- Supply voltage range 2 to 20 V
- Output TTL compatible
- Slew rate 50 V/μs
- Input offset voltage 2 nV(typ)
- Input offset current 30 nA(typ)



OFFSET NULL
INV IN
NON-INV IN
V–
OFFSET NULL
V+
OUT
FREQ COMP
1
2
3
4
5
6
7
8

Package FE, N

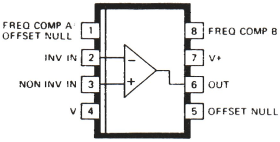
operational amplifiers

abridged data

High performance op amp TDA0301

Temperature range:
Commercial 0 °C to 70 °C TDA0301D

- Typical gain 160 000
- Input offset current, typically 3,0 nA
- Input offset voltage, typically 2 mV

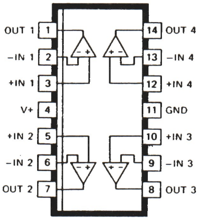

FREQ COMP A/ OFFSET NULL
1
INV IN
2
NON INV IN
3
V
4
8
FREQ COMP B
7
V+
6
OUT
5
OFFSET NULL
−
+

Package SO-8

Quad op amp TDA0324

Temperature range:
Commercial 0 °C to 70 °C TDA0324D

- Internally compensated
- Operation down to 3 V supply
- Low power supply current 200 μA per amplifier

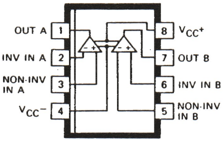

OUT 1
1
−IN 1
2
+IN 1
3
V+
4
+IN 2
5
−IN 2
6
OUT 2
7
14
OUT 4
13
−IN 4
12
+IN 4
11
GND
10
+IN 3
9
−IN 3
8
OUT 3

Package SO-14

Dual low power op amp TDA0358

Temperature range:
Commercial 0 °C to 70 °C TDA0358D

- Internally compensated
- Operation down to 3 V supply
- Supply current typically 200 μA per amplifier

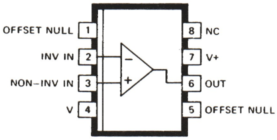

OUT A
1
INV IN A
2
NON-INV IN A
3
VCC−
4
8
VCC+
7
OUT B
6
INV IN B
5
NON-INV IN B

Package SO-8

General purpose op amp TDA0741

Temperature range:
Commercial 0 °C to 70 °C TDA0741D

- Typical open loop gain 200 000
- Offset null capability
- Output impedance 75 Ω typical


OFFSET NULL
1
INV IN
2
NON−INV IN
3
V
4
8
NC
7
V+
6
OUT
5
OFFSET NULL
−
+

Package SO-8

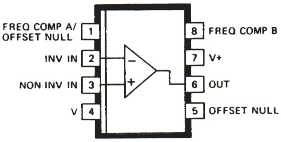
General purpose op amp

TDA0748

Temperature range:

Commercial	0 °C to 70 °C	TDA0748D

- Typical open loop gain 200 000
- Uncompensated
- Offset null capability
- Output impedance 75 Ω


FREQ COMP A/ OFFSET NULL
1
INV IN
2
NON-INV IN
3
V
4
8
FREQ COMP B
7
V+
6
OUT
5
OFFSET NULL
−
+

Package SO-8

High performance op amp

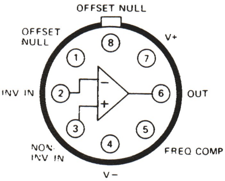
TDA1034
NE/SE5534

Temperature range:

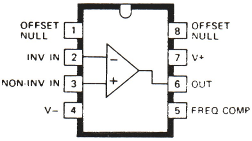
Military	−55 °C to 125 °C	SE5534FE, N, T
Industrial	−25 °C to 85 °C	TDA1034FE, N, T
Commercial	0 °C to 70 °C	SE5534FE, N, T

- Input noise voltage 3,5 nV/√Hz(typ)
- Input noise current 0,4 pA/√Hz(typ)
- Input offset voltage 0,5 mV(typ)
- Input offset current 20 nA(typ)
- Slew rate 13 V/ns
- Small signal bandwidth 10 MHz

Power bandwidth at $V_{OUT(p\text{-}p)}$ = 20 V	typ 200 kHz
Noise voltage at 1 kHz	3,5 nV/√Hz
at 30 Hz	5,5 nV/√Hz


OFFSET NULL
OFFSET NULL
V+
INV IN
OUT
NON-INV IN
FREQ COMP
V−
1
2
3
4
5
6
7
8
−
+

Package T


OFFSET NULL
1
INV IN
2
NON-INV IN
3
V−
4
8
OFFSET NULL
7
V+
6
OUT
5
FREQ COMP
−
+

Package FE, N

operational amplifiers

abridged data

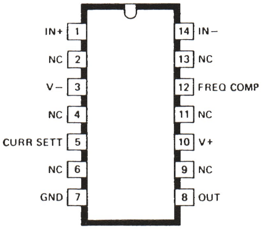
High slew rate op amp

TDA1078
NE5539

Temperature range:

Commercial	0 °C to 70 °C	TDA1078, NE5539N

- High open loop gain
- High slew rate
- High bandwidth
- High output current
- Not compensated
- Power response 64 MHz


IN+ 1
NC 2
V– 3
NC 4
CURR SETT 5
NC 6
GND 7
14 IN–
13 NC
12 FREQ COMP
11 NC
10 V+
9 NC
8 OUT

Package N-14

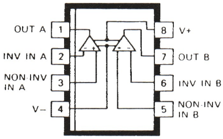
Dual general purpose op amp

TDA1458

Temperature range:

Commercial	0 °C to 70 °C	TDA1458D

- Typical gain 100 000
- Internally compensated
- Unity gain slew rate 0,8 V/μs


OUT A 1
INV IN A 2
NON-INV IN A 3
V– 4
8 V+
7 OUT B
6 INV IN B
5 NON-INV IN B

Package SO-8

differential amplifiers

abridged data

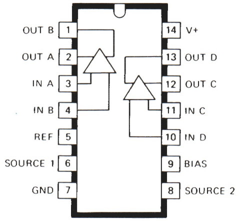
Dual differential amplifier

NE/SE510

Temperature range:

Military	–55 °C to 125 °C	SE510F, N
Commercial	0 °C to 70 °C	NE510N

- Low input offset voltage –0,5 mV typical
- Bandwidth greater than 100 MHz
- AGC capability



OUT B 1
OUT A 2
IN A 3
IN B 4
REF 5
SOURCE 1 6
GND 7
14 V+
13 OUT D
12 OUT C
11 IN C
10 IN D
9 BIAS
8 SOURCE 2

Package F, N-14

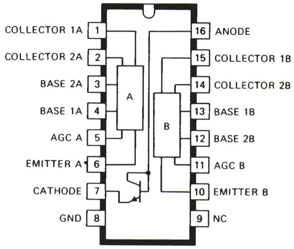
Dual differential transistor pair

NE/SE511

Temperature range:

Military	–55 °C to 125 °C	SE511F, N
Commercial	0 °C to 70 °C	NE511F, N

- Low input offset voltage –0,5 mV typical
- Operation up to 100 MHz
- AGC capability



COLLECTOR 1A 1
COLLECTOR 2A 2
BASE 2A 3
BASE 1A 4
AGC A 5
EMITTER A 6
CATHODE 7
GND 8
A
B
16 ANODE
15 COLLECTOR 1B
14 COLLECTOR 2B
13 BASE 1B
12 BASE 2B
11 AGC B
10 EMITTER B
9 NC

Package F, N-14

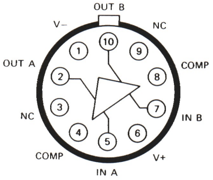
Differential amplifier

NE/SE515

Temperature range:

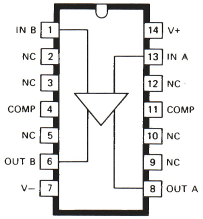
Military	–55 °C to 125 °C	SE515K, N
Commercial	0 °C to 70 °C	NE515K, N

- Differential inputs and outputs
- Open loop gain 4,500 (typ)
- Bandwidth (open loop) 1 MHz
- Input offset voltage typical 0,5 mV



OUT B
V–
NC
OUT A
COMP
NC
IN B
COMP
V+
IN A
1
2
3
4
5
6
7
8
9
10

Package K



IN B 1
NC 2
NC 3
COMP 4
NC 5
OUT B 6
V– 7
14 V+
13 IN A
12 NC
11 COMP
10 NC
9 NC
8 OUT A

Package N-14

comparators

selection guide

device no.	complexity	temp. range	max inp. offset volt. mV	max inp. current bias µA	offset µA	supply voltage V	response time (typ) ns	common mode voltage range V
µA710	single	military	3,00	45,0	7,00	+12, –6	40	± 5
µA710C	single	commercial	6,50	40,0	7,50	+12, –6	40	± 5
LM111	single	military	4,00	0,15	0,02	± 15	200	± 14
LM211	single	industrial	4,00	0,15	0,02	to	200	± 14
LM311	single	commercial	10,0	0,30	0,07	+5 and GND	200	± 14
NE526	single	commercial	5,00	35,0	5,00	+5, –5	40	–3,2, +4,2
SE526	single	military	5,00	35,0	5,00	+5, –5	40	–3,2, +4,2
NE527	single	commercial	10,0	4,00	1,00	± 5 to ± 15	16	± 6
SE527	single	military	6,00	4,00	1,00	and GND	16	± 6
NE529	single	commercial	10,0	50,0	15,0	± 5 to ± 15	12	± 6
SE529	single	military	6,00	36,0	9,00	and GND	12	± 6
LM119	dual	military	7,00	1,00	0,10	± 15	80	± 13
LM219	dual	industrial	7,00	1,00	0,10	to	80	± 13
LM319	dual	commercial	10,0	1,20	0,30	+5 and GND	80	± 13
LM193	dual	military	9,00	0,30	0,10	± 1 to ± 18	1300	± 18
LM293	dual	industrial	9,00	0,40	0,15	or	1300	± 18
LM393	dual	commercial	9,00	0,40	0,15	+2 to +36 GND	1300	± 18
LM2903	dual	ext. ind.	15,0	0,50	0,20		1300	± 18
NE521	dual	commercial	10,0	40,0	12,0	+5, –5, GND	4,5	± 3
NE522	dual	commercial	10,0	40,0	12,0	+5, –5, GND	6	± 3
µA711	dual	military	6,00	150	20,0	+12, –6	40	± 5
µA711C	dual	commercial	10,0	150	25,0	+12, –6	40	± 5
TDA0319	dual	commercial	10,0	1,20	0,30	+5 and GND	80	± 13
LM139	quad	military	9,00	0,30	0,10		1300	V_S-2
LM239	quad	industrial	9,00	0,40	0,15	± 1 to ± 18 or	1300	V_S-2
LM339	quad	commercial	9,00	0,40	0,15	+2 to +36	1300	V_S-2
LM2901	quad	ext. ind.	15,0	0,50	0,20		1300	V_S-2
LM139A	quad	military	4,00	0,30	0,10	+2 to +36	1300	V_S-2
LM239A	quad	industrial	4,00	0,40	0,15	and GND	1300	V_S-2
LM339A	quad	commercial	4,00	0,40	0,15		1300	V_S-2
MC3302	quad	ext. ind.	40,0	1,00	0,20	+2 to +28 GND	2000	V_S-2

output voltage		output structure	voltage gain (typ) V/mV	TTL fan out	max diff. inp. voltage V	packages	comments	page
V_{OLmax} V	V_{OHmin} V							
0	2,5	TTL	1,7	1	± 5	F, T	differential input	B47
0	2,5	TTL	1,5	1	± 5	F, FE, N N-14, T	single ended output	
0,4	V_S	open coll.	200	5	± 30	F, T	with strobe; will operate from	B46
0,4	V_S	open coll.	200	5	± 30	F, FE, N	single supply	
0,4	V_S	open coll.	200	5	± 30	N-14, T		
0,4	2,8	TTL		10	5	F, K, N-14	plus TTL output gate	B49
0,4	2,8	TTL		10	5	F, K, N-14		
0,5	2,7	TTL	5	5	± 5	K, N-14	complementary output	B49
0,5	2,5	TTL	5	5	± 5	K	gates with individual strobes	
0,5	2,7	TTL	5	5	± 5	K, N-14	complementary output	B50
0,5	2,5	TTL	5	5	± 5	K	gates with individual strobes	
0,6	V_S	open coll.	40	2	± 5	F, K	will operate from single	B46
0,6	V_S	open coll.	40	2	± 5	F, K	or dual supplies	
0,6	V_S	open coll.	40	2	± 5	F, K, N-14		
0,7	V_S	open coll.	200	2	36	T	will operate from single	B47
0,7	V_S	open coll.	200	2	36	FE, N, T	or dual supplies	
0,7	V_S	open coll.	200	2	36	FE, N, T		
0,7	V_S	open coll.	100	2	36	FE, N		
0,5	2,7	TTL	5	12	± 6	F, N-14	ultra-high speed	B48
0,5	V_S	open coll.	5	12	± 6	F, N-14		B49
0	2,5	TTL	1,5	2	± 5	F, K, N-14	differential in, common out,	B48
0	2,5	TTL	1,5	2	± 5	F, K, N-14	individual strobes	
0,6	V_S	open coll.	40	2	± 5	SO-10		B50
0,7	V_S	open coll.	200	2	36	F		B46
0,7	V_S	open coll.	200	2	36	F, N-14	will operate from single	
0,7	V_S	open coll.	200	2	36	F, N-14	or dual supplies	
0,7	V_S	open coll.	100	2	36	F, N-14		
0,7	V_S	open coll.	200	2	36	F	will operate from single	B47
0,7	V_S	open coll.	200	2	36	F, N-14	or dual supplies	
0,7	V_S	open coll.	200	2	36	F, N-14		
0,4	V_S	open coll.	30	2	28	N-14	will operate from single or dual supplies	B48

comparators

abridged data

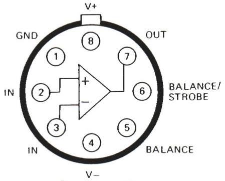
Precision voltage comparator

LM111/211/311

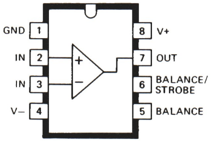
Temperature range:

Military	–55 °C to 125 °C	LM111F, T
Industrial	–25 °C to 85 °C	LM211F, FE, N, T
Commercial	0 °C to 70 °C	LM311F, FE, N, T

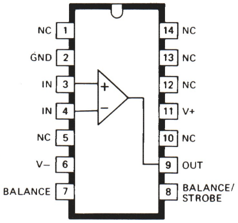
- Operates from single 5 V supply
- Voltage gain 200 000 typical
- Input bias current
  - Military 60 nA typical
  - Industrial 100 nA typical


V+
GND
OUT
8
1
7
IN
2
6
BALANCE/
STROBE
3
5
4
IN
BALANCE
V–

Package T


GND 1
IN 2
IN 3
V– 4
8 V+
7 OUT
6 BALANCE/
STROBE
5 BALANCE

Package FE, N


NC 1
GND 2
IN 3
IN 4
NC 5
V– 6
BALANCE 7
14 NC
13 NC
12 NC
11 V+
10 NC
9 OUT
8 BALANCE/
STROBE

Package F, N-14

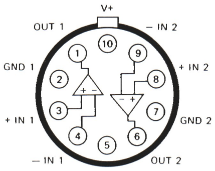
Dual voltage comparator

LM119/219/319

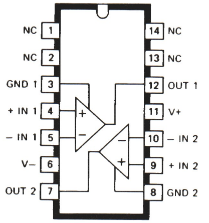
Temperature range:

Military	–55 °C to 125 °C	LM119F, K
Industrial	–25 °C to 85 °C	LM219F, K
Commercial	0 °C to 70 °C	LM319F, K, N

- Operates from single supply
- Output can be level shifted
- Input bias current typically 250 nA
- Minimum fan-out 2 each side
- High common mode slew rate
- 8 ns response time (± 15 V)


V+
OUT 1
– IN 2
10
1
9
GND 1
+ IN 2
2
8
3
7
+ IN 1
GND 2
4
6
5
– IN 1
OUT 2
V–

Package K


NC 1
NC 2
GND 1 3
+ IN 1 4
– IN 1 5
V– 6
OUT 2 7
14 NC
13 NC
12 OUT 1
11 V+
10 – IN 2
9 + IN 2
8 GND 2

Package F, N-14

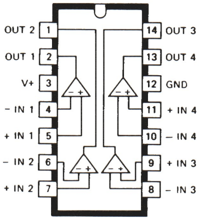
Quad comparator

LM139/239/339/2901

Temperature range:

Military	–55 °C to 125 °C	LM139F
Ext. Ind.	–40 °C to 85 °C	LM2901F, N
Industrial	–25 °C to 85 °C	LM239F, N
Commercial	0 °C to 70 °C	LM339F, N

- Single voltage supply
- Operation down to 2 V
- Offset current 3 nA(typ)
- Offset voltage 5 mV(max)
- Input bias current 35 nA(typ)
- Output TTL compatible


OUT 2 1
OUT 1 2
V+ 3
– IN 1 4
+ IN 1 5
– IN 2 6
+ IN 2 7
14 OUT 3
13 OUT 4
12 GND
11 + IN 4
10 – IN 4
9 + IN 3
8 – IN 3

Package F, N-14

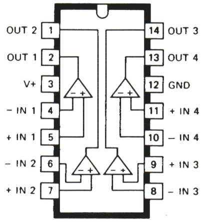
Quad comparator

LM139A/239A/339A

Temperature range:

Military	–55 °C to 125 °C	LM139AF
Industrial	–25 °C to 85 °C	LM239AF, N
Commercial	0 °C to 70 °C	LM339AF, N

- Single voltage supply
- Operation down to 2 V
- Offset current 3 nA(typ)
- Offset voltage 2 mV(max)
- Input bias current 35 nA(typ)
- Output TTL compatible


OUT 2 1
OUT 1 2
V+ 3
– IN 1 4
+ IN 1 5
– IN 2 6
+ IN 2 7
14 OUT 3
13 OUT 4
12 GND
11 + IN 4
10 – IN 4
9 + IN 3
8 – IN 3

Package F, N-14

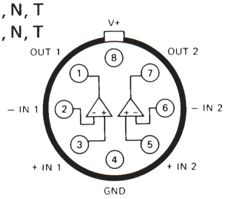
Dual comparator

LM193/293/393/2903

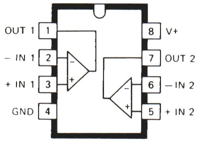
Temperature range:

Military	–55 °C to 125 °C	LM193T
Ext. Ind.	– 40 °C to 85 °C	LM2903FE, N
Industrial	–25 °C to 85 °C	LM293FE, N, T
Commercial	0 °C to 70 °C	LM393FE, N, T

- Single supply voltage
- Operation down to 2 V
- Offset current 3 nA(typ)
- Offset voltage 2 mV(max)
- Input bias current 35 nA(typ)
- Output TTL compatible


V+
OUT 1
OUT 2
– IN 1
– IN 2
+ IN 1
+ IN 2
GND
1
2
3
4
5
6
7
8

Package T


OUT 1 1
– IN 1 2
+ IN 1 3
GND 4
8 V+
7 OUT 2
6 – IN 2
5 + IN 2

Package FE, N

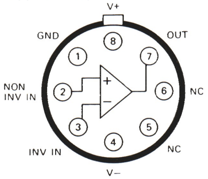
Comparator

µA710/710C

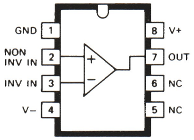
Temperature range:

Military	–55 °C to 125 °C	µA710F, T
Commercial	0 °C to 70 °C	µA710CF, FE, N, T

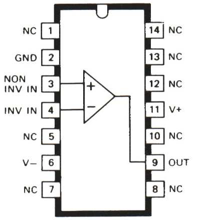
- Typical gain 1700
- Offset voltage temperature coefficient, 3,5 µV/ °C
- Typical response time 40 ns


V+
GND
OUT
NON INV IN
NC
INV IN
NC
V–
1
2
3
4
5
6
7
8

Package T


GND 1
NON INV IN 2
INV IN 3
V– 4
8 V+
7 OUT
6 NC
5 NC

Package FE, N


NC 1
GND 2
NON INV IN 3
INV IN 4
NC 5
V– 6
NC 7
14 NC
13 NC
12 NC
11 V+
10 NC
9 OUT
8 NC

Package F, N-14

comparators

abridged data

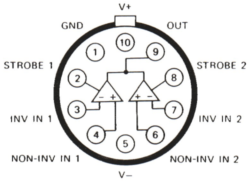
Dual comparator

μA711/711C

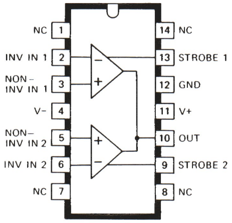
Temperature range:

Military	−55 °C to 125 °C	μA711F, K, N
Commercial	0 °C to 70 °C	μA711CF, K, N

- Typical gain 1700
- Input strobes
- Typical response time, 40 ns


V+
GND
OUT
STROBE 1
STROBE 2
INV IN 1
INV IN 2
NON-INV IN 1
NON-INV IN 2
V−
1
2
3
4
5
6
7
8
9
10

Package K


NC 1
INV IN 1 2
NON-INV IN 1 3
V− 4
NON-INV IN 2 5
INV IN 2 6
NC 7
14 NC
13 STROBE 1
12 GND
11 V+
10 OUT
9 STROBE 2
8 NC

Package F, N-14

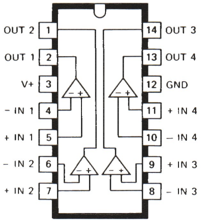
Quad voltage comparator

MC3302

Temperature range:

Ext. Ind.	−40 °C to 85 °C	MC3302N

- TTL compatible
- Differential input voltage ± V_{CC}
- Single supply +2 V to +28 V
- Input common mode voltage to GND
- Low current drain


OUT 2 1
OUT 1 2
V+ 3
− IN 1 4
+ IN 1 5
− IN 2 6
+ IN 2 7
14 OUT 3
13 OUT 4
12 GND
11 + IN 4
10 − IN 4
9 + IN 3
8 − IN 3

Package N-14

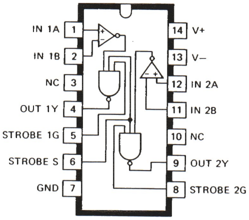
Dual high-speed comparator

NE521

Temperature range:

Commercial	0 °C to 70 °C	NE521F, N

- Schottky linear process
- 8 ns typical propagation delay
- Typical offset voltage 6 mV
- Totem-pole outputs


IN 1A 1
IN 1B 2
NC 3
OUT 1Y 4
STROBE 1G 5
STROBE S 6
GND 7
14 V+
13 V−
12 IN 2A
11 IN 2B
10 NC
9 OUT 2Y
8 STROBE 2G

Package F, N-14

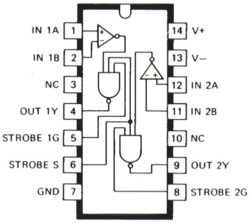
Dual high-speed comparator

NE522

Temperature range:

Commercial	0 °C to 70 °C	NE522F, N

- Schottky linear process
- 10 ns typical propagation delay
- Typical offset voltage 6 mV
- Open collector outputs


IN 1A
1
IN 1B
2
NC
3
OUT 1Y
4
STROBE 1G
5
STROBE S
6
GND
7
14
V+
13
V–
12
IN 2A
11
IN 2B
10
NC
9
OUT 2Y
8
STROBE 2G

Package F, N-14

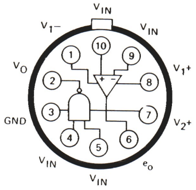
Precision voltage comparator

NE/SE526

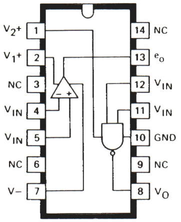
Temperature range:

Military	–55 °C to 125 °C	SE526F, K, N
Commercial	0 °C to 75 °C	NE526F, K, N

- Typical offset current 0,5 μA
- Typical offset voltage 2 mV
- TTL fan-out of 10


V_{IN}
V_1-
V_{IN}
V_O
V_1+
GND
V_2+
V_{IN}
e_o
V_{IN}
1
2
3
4
5
6
7
8
9
10

Package K


V_2+
1
V_1+
2
NC
3
V_{IN}
4
V_{IN}
5
NC
6
V–
7
14
NC
13
e_o
12
V_{IN}
11
V_{IN}
10
GND
9
NC
8
V_O

Package F, N-14

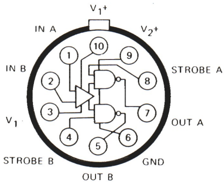
High-speed comparator

NE/SE527

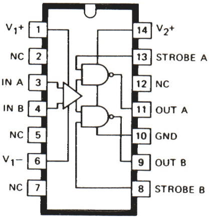
Temperature range:

Military	–55 °C to 125 °C	SE527K
Commercial	0 °C to 70 °C	NE527K, N

- Low offset current 0,3 μA (typ)
- Low offset voltage, 2 mV (typ)
- Complementary outputs
- Typical propagation delay, 15 ns


V_1+
IN A
V_2+
IN B
STROBE A
V_1
OUT A
STROBE B
GND
OUT B
1
2
3
4
5
6
7
8
9
10

Package K


V_1+
1
NC
2
IN A
3
IN B
4
NC
5
V_1-
6
NC
7
14
V_2+
13
STROBE A
12
NC
11
OUT A
10
GND
9
OUT B
8
STROBE B

Package N-14

comparators

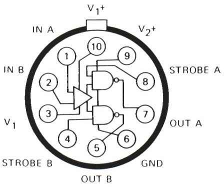
abridged data

High-speed comparator

NE/SE529

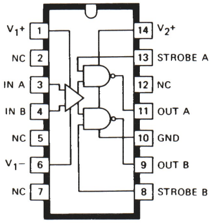
Temperature range:
Military −55 °C to 125 °C SE529K
Commercial 0 °C to 70 °C NE529K, N

- Offset current 2 μA (typ)
- Low offset voltage 2 mV (typ)
- Complementary outputs
- Typical propagation delay 11 ns



V_1+
IN A
V_2+
IN B
STROBE A
V_1
OUT A
STROBE B
GND
OUT B
1
2
3
4
5
6
7
8
9
10

Package K



V_1+ 1
NC 2
IN A 3
IN B 4
NC 5
V_1− 6
NC 7
14 V_2+
13 STROBE A
12 NC
11 OUT A
10 GND
9 OUT B
8 STROBE B

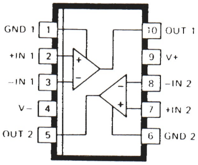
Package N-14

Dual voltage comparator

TDA0319

Temperature range:
Commercial 0 °C to 70 °C TDA0319D

- Operates from single 5 V supply
- Output can be level shifted
- Input bias current typically 250 nA



GND 1 1
+IN 1 2
−IN 1 3
V− 4
OUT 2 5
10 OUT 1
9 V+
8 −IN 2
7 +IN 2
6 GND 2
+
−
−
+

Package SO-10

voltage regulators

selection guide

device no.	polarity and function	input voltage range V	output voltage range V	max outp. current A	peak outp. current A	typ line regulation %	typ load regulation %
LM109/309	5 V pos.; fixed	7,0 to 35	4,8 to 5,2	1,0	2,2	1,0	2,0
LM340-5	5 V pos.; fixed	7,0 to 35	4,8 to 5,2	1,0	2,2	1,0	1,0
LM340-6	6 V pos.; fixed	8,0 to 35	5,75 to 6,25				
LM340-8	8 V pos.; fixed	10 to 35	7,7 to 8,3				
LM340-12	12 V pos.; fixed	14 to 35	11,5 to 12,5				
LM340-15	15 V pos.; fixed	17 to 35	14,4 to 15,6				
LM340-18	18 V pos.; fixed	20 to 35	17,3 to 18,7				
LM340-24	24 V pos.; fixed	26 to 40	23 to 25				
NE/SE550	precision adjustable	8,5 to 40	2,0 to 37	0,125	0,150	0,1	0,4
NE/SE5551	dual polarity regulators	± 3,2	± 5	–	0,4	–	–
NE/SE5552			± 6				
NE/SE5553			± 12				
NE/SE5554			± 15				
NE/SE5555			+ 5; –12				
μA723/723C	precision adjustable	9,5 to 40	2,0 to 37	0,125	0,150	0,1	0,6
7805	5 V pos.; fixed	7,0 to 35	4,8 to 5,2	1,0	2,2	1,0	1,0
7806	6 V pos.; fixed	8,0 to 35	5,75 to 6,25		2,2		
7808	8 V pos.; fixed	10 to 35	7,7 to 8,3		2,2		
7812	12 V pos.; fixed	14 to 35	11,5 to 12,5		2,2		
7815	15 V pos.; fixed	17 to 35	14,4 to 15,6		2,1		
7818	18 V pos.; fixed	20 to 35	17,3 to 18,7		2,1		
7824	24 V pos.; fixed	26 to 40	23 to 25		2,1		
78G *	pos.; adjustable	7,5 to 40	5,0 to 30	1,0	2,1	0,75	1,0
78L02AC	2,6 V pos.; fixed	4,3 to 30	2,5 to 2,7	0,15		2,0	1,0
78L05AC	5 V pos.; fixed	6,7 to 30	4,8 to 5,2				
78L06AC	6,2 V pos.; fixed	7,9 to 30	5,95 to 6,45				
78L08AC *	8,2 V pos.; fixed	9,9 to 30	7,9 to 8,5				

* Type in development.

For special voltage requirements contact us — see back cover for address

typ quiesc. current mA	min ripple rejection dB	min dropout voltage V	av temp. coefficient mV/°C	packages with corresponding max. θ						page
					$\theta_{j\text{-}c}$ °C/W	$\theta_{j\text{-}a}$		$\theta_{j\text{-}c}$ °C/W	$\theta_{j\text{-}a}$	
5,0		2,0	–0,8	TO-220	5,0	65	TO-3	5,5	45	B56
4,2	62	2,0	–1,1	TO-220	5,0	65	TO-3	5,5	45	B56
4,3	59		–0,8							
4,3	56		–0,8							
4,3	61		–1,0							
4,4	60		–1,0							
4,5	59		–1,0							
4,6	56		–1,5							
1,6	75	3,0	–0,015	TO-100	25	150	TO-116	65	150	B56
+1,7; –5,6	–	–	1	N	25	150	T	35	95	B57
2,3	74	3,0	–0,015	TO-100	25	150	TO-116	65	150	B56
4,2	62	2,0	–1,1	TO-220	5,0	65	TO-3	5,5	45	B59
4,3	59		–0,8							
4,3	56		–0,8							
4,3	61		–1,0							
4,4	60		–1,0							
4,5	59		–1,0							
4,6	56		–1,5							
3,2	62	2,5	–1,1	U1	11	80	TO-3	6,0	47	B57
3,6	43	1,7		TO-39	40	190	TO-92	70	200	B57
3,8	41									
3,9	39									
4,0	38									

voltage regulators

selection guide

device no.	polarity and function	input voltage range V	output voltage range V	max outp. current A	peak outp. current A	typ line regulation %	typ load regulation %
78L12AC	12 V pos.; fixed	13,7 to 35	11,5 to 12,5	0,15		2,0	1,0
78L15AC	15 V pos.; fixed	16,7 to 35	14,4 to 15,6				
78L18AC *	18 V pos.; fixed	19,7 to 35	17,3 to 18,9				
78L24AC	24 V pos.; fixed	25,7 to 35	23,1 to 14,9				
78M05	5 V pos.; fixed	7,0 to 30	4,8 to 5,2	0,5	0,7	1,0	1,0
78M06	6 V pos.; fixed	8,0 to 30	5,75 to 6,25				
78M08	8 V pos.; fixed	10 to 30	7,7 to 8,3				
78M12	12 V pos.; fixed	14 to 35	11,5 to 12,5				
78M15	15 V pos.; fixed	17 to 35	14,4 to 15,6				
78M20	20 V pos.; fixed	22 to 40	19 to 21				
78M24	24 V pos.; fixed	26 to 40	23 to 25				
78MG	pos.; adjustable	7,5 to 40	5,0 to 30	0,5	0,8	0,75	1,0
7905	5 V neg.; fixed	−7,2 to −35	−4,8 to −5,2	1,0	2,1	1,0	1,0
7906	6 V neg.; fixed	−8,3 to −35	−5,75 to −6,25				
7908	8 V neg.; fixed	−10,3 to −35	−7,7 to −8,3				
7912	12 V neg.; fixed	−14,5 to −35	−11,5 to −12,5				
7915	15 V neg.; fixed	−17,6 to −35	−14,4 to −15,6				
7918	18 V neg.; fixed	−20,7 to −35	−17,3 to −18,7				
7924	24 V neg.; fixed	−27 to −40	−23 to −25				
79G	neg.; adjustable	−7,0 to −40	−2,23 to −30	1,0	2,2	1,0	1,0
79M05	5 V neg.; fixed	−7,5 to −35	−5,2 to −4,8	0,5	0,65	1,0	1,0
79M06	6 V neg.; fixed	−7,35 to −35	−6,25 to −5,75				
79M08	8 V neg.; fixed	−9,4 to −35	−8,3 to −7,7				
79M12	12 V neg.; fixed	−13,6 to −35	−12,5 to −11,5				
79M15	15 V neg.; fixed	−16,7 to −35	−15,6 to −14,4				
79M20	20 V neg.; fixed	−22,1 to −40	−20 to −19				
79M24	24 V neg.; fixed	−26,1 to −40	−25 to −23				
79MG	neg.; adjustable	−7,0 to −40	−2,2 to −30	0,5	0,65	0,75	1,0
TDA0723	precision adjustable	9,5 to 40	2,0 to 37	0,125	0,150	0,1	0,6

* Type in development.

For special voltage requirements contact us — see back cover for address

typ quiesc. current mA	min ripple rejection dB	min dropout voltage V	av temp. coefficient mV/°C	packages with corresponding max θ						page
					$\theta_{j\text{-}c}$ °C/W	$\theta_{j\text{-}a}$		$\theta_{j\text{-}c}$ °C/W	$\theta_{j\text{-}a}$	
4,2	36	1,7		TO-39	40	190	TO-92	70	200	B57
4,4	33									
4,6										
4,8										
4,2	62	2,0	−1,0	TO-220	5,0	70	TO-39	25	185	B57
4,3	59		−0,5							
4,3	56		−0,5							
4,3	55		−1,0							
4,4	54		−1,0							
4,5	53		−1,1							
4,6	50		−1,2							
2,8	78	2,5	−0,5	TO-39	25	185	U1	11	80	B58
1,0	54	2,0	−0,4	TO-3	5,5	45	TO-220	5,0	65	B59
			−0,4							
			−0,6							
			−0,8							
			−1,0							
			−1,0							
			−1,0							
0,5	50	2,3	−0,4	U1	11	80	TO-3	6,0	47	B58
1,0	60	1,0	−0,4	TO-220	5,0	70	TO-39	25	185	B58
	60		−0,4							
	60		−0,6							
	60		−0,8							
	60		−1,0							
	59		−1,0							
	58		−1,0							
0,5	60	2,3	−0,4	TO-39	25	185	U1	11	80	B59
2,3	74	3,0	−0,015	SO-10						B59

voltage regulators

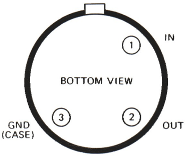
abridged data

Fixed 5 volt regulator **LM109/209/309**

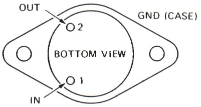
Temperature range:

Military	−55 °C to 125 °C	LM109DA, DB
Industrial	−25 °C to 85 °C	LM209DA, DB
Commercial	0 °C to 70 °C	LM309DA, DB

- Fixed 5 V output
- Short-circuit and thermal overload protection
- 1 A capability in TO-3


IN
1
BOTTOM VIEW
GND
(CASE)
3
2
OUT

Package DB


OUT
GND (CASE)
2
BOTTOM VIEW
1
IN

Package DA

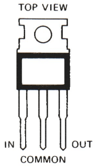
Fixed positive voltage regulators **LM340 series**

Temperature range (junction):

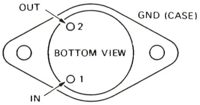
Military	−55 °C to 125 °C	LM340DA
Commercial	0 °C to 125 °C	LM340DA, U

- 1 A output
- Short-circuit and overload protection

LM340-5	5 V
LM340-6	6 V
LM340-8	8 V
LM340-12	12 V
LM340-15	15 V
LM340-18	18 V
LM340-24	24 V


TOP VIEW
IN
OUT
COMMON

Package U


OUT
GND (CASE)
2
BOTTOM VIEW
1
IN

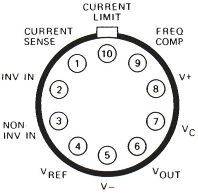
Package DA

Variable voltage regulator **μA723/723C**

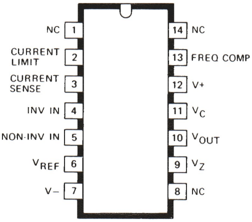
Temperature range:

Military	−55 °C to 125 °C	μA723F, K, N
Commercial	0 °C to 70 °C	μA723CK, N

- Output voltage range, 2 to 37 V
- 150 mA output current capability
- 7,15 V reference


CURRENT LIMIT
CURRENT SENSE
FREQ COMP
10
1
9
INV IN
2
8
V+
NON-INV IN
3
7
VC
4
5
6
VREF
VOUT
V−

Package K


NC 1
CURRENT LIMIT 2
CURRENT SENSE 3
INV IN 4
NON-INV IN 5
VREF 6
V− 7
14 NC
13 FREQ COMP
12 V+
11 VC
10 VOUT
9 VZ
8 NC

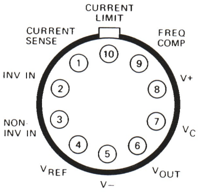
Package F, N-14

Variable voltage regulator **NE/SE550**

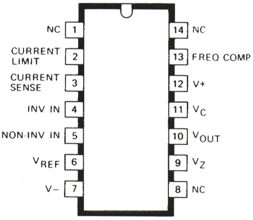
Temperature range:

Military	−55 °C to 125 °C	SE550F, K
Commercial	0 °C to 70 °C	NE550F, K, N

- Output voltage range, 2 to 37 V
- 150 mA output current capability
- 1,63 V reference


CURRENT LIMIT
CURRENT SENSE
FREQ COMP
10
1
9
INV IN
2
8
V+
NON-INV IN
3
7
VC
4
5
6
VREF
VOUT
V−

Package K


NC 1
CURRENT LIMIT 2
CURRENT SENSE 3
INV IN 4
NON-INV IN 5
VREF 6
V− 7
14 NC
13 FREQ COMP
12 V+
11 VC
10 VOUT
9 VZ
8 NC

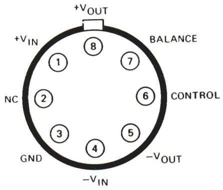
Package F, N-14

Dual polarity regulators NE/SE5551 to 55

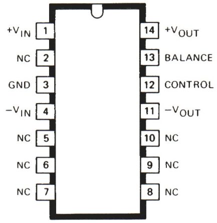
Temperature range:

Military	–55 °C to 155 °C	SE5551 to 55F, N, T
Commercial	0 °C to 150 °C	NE5551 to 55F, N, T

- Internally current-limited
- Thermal overload protection
- Continuously adjustable from 5 to 20 V, balanced or unbalanced
- No external components required


+V$_{OUT}$
+V$_{IN}$
BALANCE
8
1
7
NC
2
6
CONTROL
3
5
4
GND
–V$_{OUT}$
–V$_{IN}$

Package T


+V$_{IN}$ 1
NC 2
GND 3
–V$_{IN}$ 4
NC 5
NC 6
NC 7
14 +V$_{OUT}$
13 BALANCE
12 CONTROL
11 –V$_{OUT}$
10 NC
9 NC
8 NC

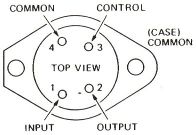
Package F, N-14

Adjustable positive voltage regulator 78G

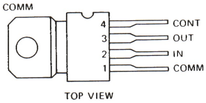
Temperature range (junction):

Military	–55 °C to 150 °C	78G, DA
Commercial	0 °C to 150 °C	78GC, DA, U1

- Output current in excess of 1,0 A
- 78G positive output voltage 5 to 30 V
- Internal thermal overload protection
- Internal short-circuit current protection
- Output transistor safe area protection
- Military and commercial versions available
- Available in 4-pin TO-202 type and 4-pin TO-3


COMMON
CONTROL
(CASE)
COMMON
4
3
TOP VIEW
1
2
INPUT
OUTPUT

Package DA


COMM
4 CONT
3 OUT
2 IN
1 COMM
TOP VIEW

Package U1

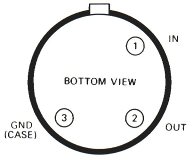
Fixed positive voltage regulators 78L00 series

Temperature range (junction):

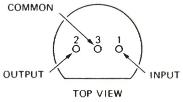
Military	–55 °C to 150 °C	78L00DB
Commercial	0 °C to 150 °C	78L00CS, DB

- 0,1 A output
- Short-circuit and overload protection

78L02	2,6 V	78L12	12 V
78L05	5 V	78L15	15 V
78L06	6,2 V	78L18	18 V
78L08	8,2 V	78L24	24 V


IN
1
BOTTOM VIEW
GND
(CASE)
3
2
OUT

Package DB


COMMON
2
3
1
OUTPUT
INPUT
TOP VIEW

Package S

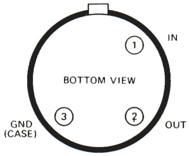
Fixed positive voltage regulators 78M00 series

Temperature range (junction):

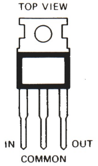
Military	–55 °C to 150 °C	78M00DB
Commercial	0 °C to 150 °C	78M00C, DB, U

- 0,5 A output
- Short-circuit and overload protection

78M05	5 V
78M06	6 V
78M08	8 V
78M12	12 V
78M15	15 V
78M20	20 V
78M24	24 V


IN
1
BOTTOM VIEW
GND
(CASE)
3
2
OUT

Package DB


TOP VIEW
IN
OUT
COMMON

Package U

voltage regulators

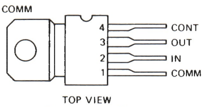
abridged data

Adjustable positive voltage regulator 78MG

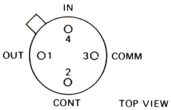
Temperature range (junction):

Military	−55 °C to 150 °C	78MGDB
Commercial	0 °C to 150 °C	78GCDB, U1

- Output current in excess of 0,5 A
- μA78MG positive output voltage 5 to 30 V
- Internal thermal overload protection
- Internal short-circuit current protection
- Output transistor safe area protection
- Power miniature dual in-line package


COMM
4
3
2
1
CONT
OUT
IN
COMM
TOP VIEW

Package U1


IN
4
OUT
1
3
COMM
2
CONT
TOP VIEW

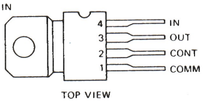
Package DB

Adjustable negative voltage regulator 79G

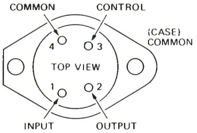
Temperature range (junction):

Military	−55 °C to 150 °C	79GDA
Commercial	0 °C to 150 °C	79GCDA, U1

- Output current in excess of 1,0 A
- 79G negative output voltage −30 to −5 V
- Internal thermal overload protection
- Internal short-circuit current protection
- Output transistor safe area protection
- Military and commercial versions available
- Available in 4-pin TO-202 type and 4-pin TO-3


IN
4
3
2
1
IN
OUT
CONT
COMM
TOP VIEW

Package U1


COMMON
CONTROL
(CASE)
COMMON
4
3
TOP VIEW
1
2
INPUT
OUTPUT

Package DA

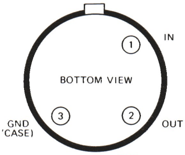
Fixed negative voltage regulators 79M00 series

Temperature range (junction):

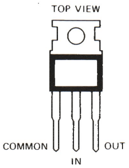
Military	−55 °C to 150 °C	79M00DB
Commercial	0 °C to 150 °C	79M00CDB, U

- 0,5 A output
- Short-circuit and overload protection

79M05	5 V
79M06	6 V
79M08	8 V
79M12	12 V
79M15	15 V
79M20	20 V
79M24	24 V


IN
①
BOTTOM VIEW
GND
(CASE)
③
②
OUT

Package DB


TOP VIEW
COMMON
IN
OUT

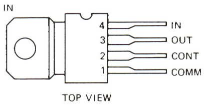
Package U

Adjustable negative voltage regulator 79MG

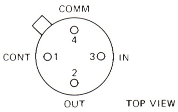
Temperature range (junction):

Military	−55 °C to 150 °C	79MGDB
Commercial	0 °C to 150 °C	79MGCDB, U1

- Output current in excess of 0,5 A
- 79MG negative output voltage −30 V to −2,2 V
- Internal thermal overload protection
- Internal short-circuit current protection
- Output transistor safe area protection
- Power miniature dual in-line package


IN
4
3
2
1
IN
OUT
CONT
COMM
TOP VIEW

Package U1


COMM
4
CONT
1
3
IN
2
OUT
TOP VIEW

Package DB

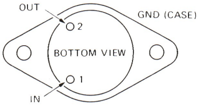
Fixed positive voltage regulators 7800 series

Temperature range (junction):

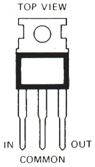
Military	−55 °C to 150 °C	7800DA
Commercial	0 °C to 150 °C	7800CDA, U

- 1 A output
- Short-circuit and overload protection

7805	5 V
7806	6 V
7808	8 V
7812	12 V
7815	15 V
7818	18 V
7824	24 V


OUT
GND (CASE)
2
BOTTOM VIEW
1
IN

Package DA


TOP VIEW
IN
OUT
COMMON

Package U

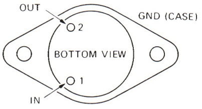
Fixed negative voltage regulators 7900 series

Temperature range (junction):

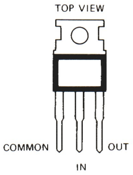
Military	−55 °C to 150 °C	7900DA
Commercial	0 °C to 150 °C	7900CDA, U

- 1 A output
- Short-circuit and overload protection

7905	5 V
7906	6 V
7908	8 V
7912	12 V
7915	15 V
7918	18 V
7924	24 V


OUT
GND (CASE)
2
BOTTOM VIEW
1
IN

Package DA


TOP VIEW
COMMON
OUT
IN

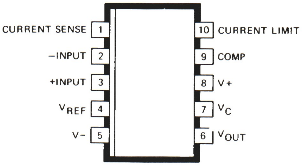
Package U

Variable voltage regulator TDA0723

Temperature range:

Military	−55 °C to 125 °C	TDA0723D
Commercial	0 °C to 70 °C	TDA0723D

- Output voltage range, 2 to 37 V
- 150 mA output current capability
- 7,15 V reference


CURRENT SENSE 1
−INPUT 2
+INPUT 3
VREF 4
V− 5
10 CURRENT LIMIT
9 COMP
8 V+
7 VC
6 VOUT

Package SO-10

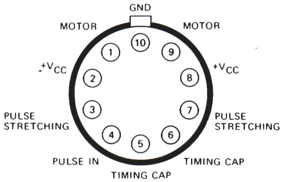
Servo amplifier **NE543**

Temperature range:

Commercial 0 °C to 70 °C NE543K

- Directly drives 11 Ω servo motor
- Few external components
- Operates from 4,5 V supply

NO LONGER RECOMMENDED
FOR NEW DESIGN


GND
MOTOR
MOTOR
+VCC
+VCC
PULSE STRETCHING
PULSE STRETCHING
PULSE IN
TIMING CAP
TIMING CAP
1
2
3
4
5
6
7
8
9
10

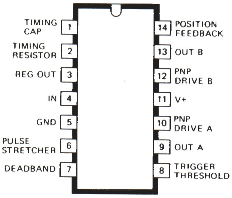
Package K

Servo amplifier **NE544**

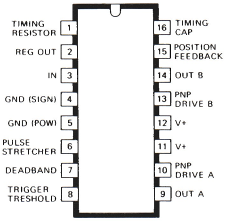
Temperature range:

Industrial –20 °C to 75 °C NE544N

- 500 mA load current capability
- Low stand-by power drain
- Bidirectional bridge output (single supply)
- Adjustable deadband/trigger thresholds
- High linearity 0,5% max error
- Output for external PNPs optional
- Wide supply range


TIMING CAP 1
TIMING RESISTOR 2
REG OUT 3
IN 4
GND 5
PULSE STRETCHER 6
DEADBAND 7
14 POSITION FEEDBACK
13 OUT B
12 PNP DRIVE B
11 V+
10 PNP DRIVE A
9 OUT A
8 TRIGGER THRESHOLD

Package N-14


TIMING RESISTOR 1
REG OUT 2
IN 3
GND (SIGN) 4
GND (POW) 5
PULSE STRETCHER 6
DEADBAND 7
TRIGGER TRESHOLD 8
16 TIMING CAP
15 POSITION FEEDBACK
14 OUT B
13 PNP DRIVE B
12 V+
11 V+
10 PNP DRIVE A
9 OUT A

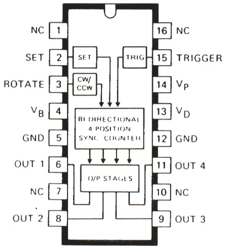
Package N-16

Stepper motor driver **SAA1027**

Temperature range:

Industrial –20 °C to 70 °C SAA1027

- Supply range 9,5 to 18 V
- Load current (each output) 350 mA(max)
- Logic on chip for clockwise/counterclockwise rotation


NC 1
SET 2
ROTATE 3
VB 4
GND 5
OUT 1 6
NC 7
OUT 2 8
16 NC
15 TRIGGER
14 VP
13 VD
12 GND
11 OUT 4
10 NC
9 OUT 3
SET
TRIG
CW/CCW
BI DIRECTIONAL 4 POSITION SYNC. COUNTER
O/P STAGES

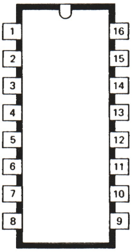
Package N-16

Industrial logic circuit **SAA1029**

Temperature range:

Industrial –30 °C to 85 °C SAA1029N

- High noise immunity
- High max input voltage
- High voltage process
- Short-circuit protected

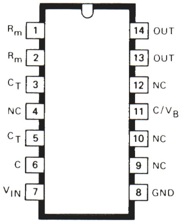

1
2
3
4
5
6
7
8
16
15
14
13
12
11
10
9

Package N-16

Revolution counter SAA1049

Temperature range:
Ext. Ind. –40 °C to 85 °C SAA1049N

- Temperature compensation
- Supply voltage compensation
- Positive triggering
- Adjustable output pulse duration



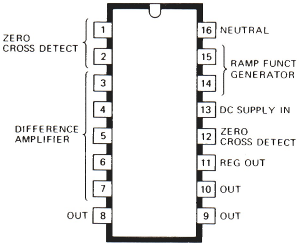
R_m 1
R_m 2
C_T 3
NC 4
C_T 5
C 6
V_{IN} 7
14 OUT
13 OUT
12 NC
11 C/V_B
10 NC
9 NC
8 GND

Package N-14

Universal triac control TCA280A

Temperature range:
Industrial –20 °C to 80 °C TCA280A

- Universal triac control
- Zero crossing
- Trigger current 200 mA(max)
- Supply current 30 mA(max)



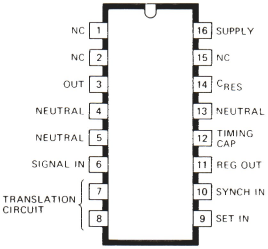
ZERO CROSS DETECT
1
2
3
4
DIFFERENCE AMPLIFIER
5
6
7
OUT 8
16 NEUTRAL
15
14
RAMP FUNCT GENERATOR
13 DC SUPPLY IN
12 ZERO CROSS DETECT
11 REG OUT
10 OUT
9 OUT

Package N-16

Time proportional triac control TDA1023

Temperature range:
Industrial –20 °C to 80 °C TDA1023

- Adjustable hysteresis
- Fail safe
- Linear temperature scale
- Trigger current 200 mA(max)
- Supply current less than 30 mA
- Zero crossing



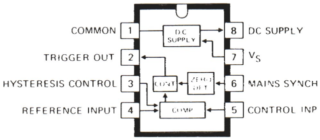
NC 1
NC 2
OUT 3
NEUTRAL 4
NEUTRAL 5
SIGNAL IN 6
TRANSLATION CIRCUIT
7
8
16 SUPPLY
15 NC
14 C_{RES}
13 NEUTRAL
12 TIMING CAP
11 REG OUT
10 SYNCH IN
9 SET IN

Package N-16

On/off triac control TDA1024

Temperature range:
Industrial –20 °C to 80 °C TDA1024

- Adjustable hysteresis
- Trigger current capability 100 mA(max)
- Supply current 10 mA(typ)
- Zero crossing



COMMON 1
TRIGGER OUT 2
HYSTERESIS CONTROL 3
REFERENCE INPUT 4
DC SUPPLY
CONT
ZERO DET
COMP
8 DC SUPPLY
7 V_S
6 MAINS SYNCH
5 CONTROL INP

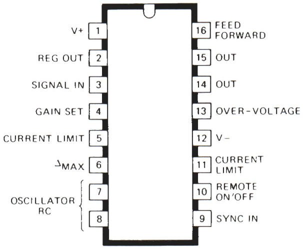
Package N

Switched mode power supply control

TDA1060

Temperature range:
Military –55 °C to 125 °C TDA1060B
Industrial –25 °C to 85 °C TDA1060

- Complete SMPS control
- δ_{max} control
- Slow start
- Current limit control
- Over-current protection
- Over-voltage protection


V+ 1
REG OUT 2
SIGNAL IN 3
GAIN SET 4
CURRENT LIMIT 5
δMAX 6
OSCILLATOR RC 7 8
16 FEED FORWARD
15 OUT
14 OUT
13 OVER-VOLTAGE
12 V–
11 CURRENT LIMIT
10 REMOTE ON/OFF
9 SYNC IN

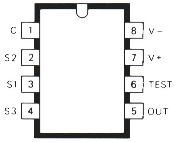
Package F, N-16

Voltage indication circuit

TDA1092

Temperature range:
Industrial –40 °C to 85 °C TDA1092N

- High voltage indication
- Low voltage indication
- Adjustable tresholds
- Temperature compensation
- Spike-protection
- 2 W output capability


C 1
S2 2
S1 3
S3 4
8 V–
7 V+
6 TEST
5 OUT

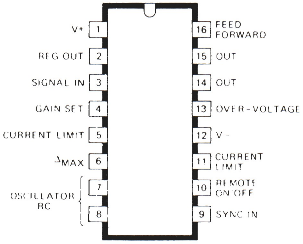
Package N

Switched mode power supply control

TDA3060

Temperature range:
Commercial 0 °C to 70 °C TDA3060

- Complete SMPS control
- δ_{max} control
- Slow start
- Current limit control
- Over-current protection
- Over-voltage protection


V+ 1
REG OUT 2
SIGNAL IN 3
GAIN SET 4
CURRENT LIMIT 5
δMAX 6
OSCILLATOR RC 7 8
16 FEED FORWARD
15 OUT
14 OUT
13 OVER-VOLTAGE
12 V–
11 CURRENT LIMIT
10 REMOTE ON OFF
9 SYNC IN

Package F, N-16

timers

abridged data

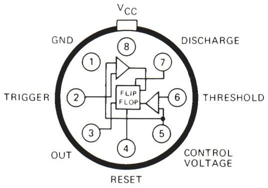
Timer

NE555
SE555/555C

Temperature range:

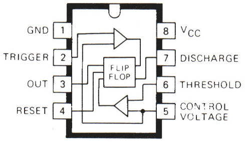
Military	−55 °C to 125 °C	SE555F, N, T/SE555CF, N, T
Commercial	0 °C to 70 °C	NE555T, N

- Timing over 9 decades
- Operates in monostable and astable modes
- 200 mA output current capability
- SE555C is industrial spec maintained over military temperature range



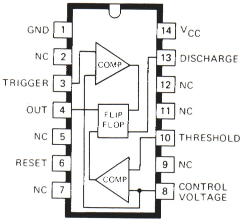
VCC
GND
DISCHARGE
8
1
7
TRIGGER
2
FLIP FLOP
6
THRESHOLD
3
5
4
OUT
CONTROL VOLTAGE
RESET

Package T



GND 1
TRIGGER 2
OUT 3
RESET 4
8 VCC
7 DISCHARGE
6 THRESHOLD
5 CONTROL VOLTAGE
FLIP FLOP

Package N



GND 1
NC 2
TRIGGER 3
OUT 4
NC 5
RESET 6
NC 7
14 VCC
13 DISCHARGE
12 NC
11 NC
10 THRESHOLD
9 NC
8 CONTROL VOLTAGE
COMP
FLIP FLOP
COMP

Package F

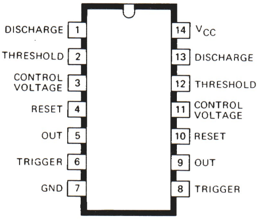
Dual timer

NE556
SE556/556C

Temperature range:

Military	−55 °C to 125 °C	SE556F, N/SE556CF, N
Commercial	0 °C to 70 °C	NE556N

- Timing over 9 decades
- Operates in monostable and astable modes
- Replaces two 555 timers
- SE556C is industrial spec maintained over military temperature range



DISCHARGE 1
THRESHOLD 2
CONTROL VOLTAGE 3
RESET 4
OUT 5
TRIGGER 6
GND 7
14 VCC
13 DISCHARGE
12 THRESHOLD
11 CONTROL VOLTAGE
10 RESET
9 OUT
8 TRIGGER

Package F, N-14

timers

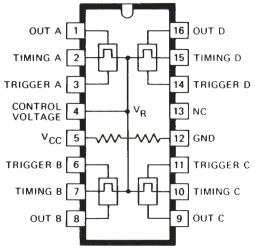
abridged data

Quad timer

NE558

Temperature range:
Commercial 0 °C to 70 °C **NE558N**

- TTL compatible inputs and outputs
- All four monostables independently adjustable
- 100 mA output sink capability


OUT A
TIMING A
TRIGGER A
CONTROL VOLTAGE
V_{CC}
TRIGGER B
TIMING B
OUT B
1
2
3
4
5
6
7
8
16
15
14
13
12
11
10
9
V_R
OUT D
TIMING D
TRIGGER D
NC
GND
TRIGGER C
TIMING C
OUT C

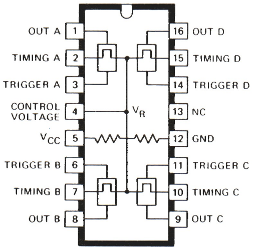
Package N-16

Quad timer

NE559

Temperature range:
Commercial 0 °C to 70 °C **NE559N**

- TTL compatible inputs
- 100 mA output source capability
- All four monostables independently adjustable


OUT A
TIMING A
TRIGGER A
CONTROL VOLTAGE
V_{CC}
TRIGGER B
TIMING B
OUT B
1
2
3
4
5
6
7
8
16
15
14
13
12
11
10
9
V_R
OUT D
TIMING D
TRIGGER D
NC
GND
TRIGGER C
TIMING C
OUT C

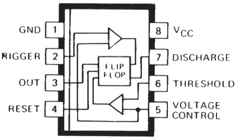
Package N-16

Timer

TDA0555

Temperature range:
Commercial 0 °C to 70 °C TDA0555D

- Timing over 9 decades
- Operates in monostable and astable modes
- 200 mA output current capability


GND
TRIGGER
OUT
RESET
1
2
3
4
8
7
6
5
FLIP FLOP
V_{CC}
DISCHARGE
THRESHOLD
VOLTAGE CONTROL

Package SO-8

interface
selection guide

Peripheral interface

Peripheral drivers (TTL compatible)

device no.	function	switching speed ns	output voltage V	comments	packages	page
75450B	NAND	30	30	separate output transistor	F, N-14	B75
75451B	NAND	25	30	output transistor is internally connected	F, N, T	B76-B77
75452B	AND	35				
75453B	NOR	25				
75454B	OR	35				
DS3611	AND	130	80	inputs compatible with TTL and MOS	N	B69-B70
DS3612	NAND	110				
DS3613	OR	125				
DS3614	NOR	220				
UDN5711	AND	750	80	all devices have suppression diodes on output	N	B74
UDN5712	NAND					
UDN5713	OR					
UDN5714	NOR					
NE590		100		sink current	F, N-16	B72
NE591		70		source current	F, N-18	

Line receivers (TTL compatible)

device no.	complexity	supply voltage V	common mode voltage V	propag. delay ns	diff. input	output enable	packages	page
MC1489	quad	+ 10		85	no	no	F, N-14	B71
MC1489A								
75S107	dual	± 5	± 3	17	yes	yes	F, N-14	B75
75S108								
DS7820	dual	± 5	± 15	40	yes	yes	F	B69
DS8820							F, N-14	
DS7820A							F	
DS8820A							F, N-14	

interface

selection guide

Peripheral interface

Data conversion products

device	function	temperature range	number of bits	settling time typ	accuracy	packages	page
MC1408-8 **MC1508-8**	DAC	commercial military	8	300 ns	± 0,19%	F, N-16	B71
NE5007 **NE5008** **SE5008**	DAC	commercial commercial military	8	100 ns	0,39% 0,19% 0,19%	F, N-16	B73
NE5009 **SE5009**	DAC	commercial military	8	60 ns	± 0,1%	F, N-16 F	B73
NE5018 **SE5018**	ADC	commercial military	8	2 μs	± 0,19%	F, N-22 F	B73

Video amplifiers

	function	bandwidth	packages	page
NE/SE501	broadband video amplifier	14	K, N-14	B72
NE/SE592	differential input video amplifier	120	F, K, N-14	B72
μA733/733C	differential input video amplifier	120	F, K, N-14	B70

Line drivers (TTL compatible)

device no.	complexity	supply voltage V	V_{OH} V	V_{OL} V	I_{OH} mA	I_{OL} mA	propag. delay ns	packages	page
MC1488	quad	± 9	−7,0	6,8	−12	12	300	F, N-14	B71
DS7830 **DS8830**	dual	+ 5	−3,3	0,5	−40	40	12	F F, N-14	B69

Display drivers

device no.	display	function	input compat.	BCD decoder	ripple blanking	output current mA	output voltage V	comments	packages	page
DS8880 **DS8880-1**	gas disch.	7-segment decoder drivers	TTL	yes	yes	0,2 to 1,5	80 100	constant current output	F, N-16	B80
NE580	bar-graph	driver	—	no	no	1	3,5		F, N-22	B80
NE582	LED	hex universal driver	MOS/TTL	no	no	400	10		F, N-16	B81
NE584-9 **NE584-8**	gas disch.	cath. driver	MOS/TTL	no	no	—	100		F, N-24 F, N-22	B81
NE585-9 **NE585-6**	gas disch.	anode driver	MOS/TTL	no	no	—	100	displays	F, N-22 F, N-16	B82
NE586 **NE588**	LED	fixed current driver	micro-processor	yes	yes	25	0,7 to 3		F, N-16, N-18	B82
NE587 **NE589**	LED	current programmable driver	micro-processor	yes	yes	0 to 15	−0,7 to −3		F, N-16, N-18	B82

Transistor arrays

device no.	function	V_{CBO} V	V_{CEO} V	V_{CEsat} V	I_C mA	current gain	comments	packages	page
CA3045	transistor array	—	—	—	—	—	—	—	B78
CA3046/86	5 transistor array	50	35	0,4	100	350	n-p-n transistors	N-14	B78
CA3081	7 transistor array	50	35	0,8	100	300	common emitter	N-16	B78
CA3082	7 transistor array						common collector		B79
CA3083	5 transistor array						separate transistor		B79
CA3183	transistor array	—	—	—	—	—	—	—	B79
NE5501	7 n-p-n Darlington pairs	6	100	1,6	350	1000	general purpose	N-16	B83
NE5502							use with PMOS		
NE5503							with TTL/CMOS		
NE5504							PMOS/CMOS		

interface

selection guide

Memory interface

Memory drivers (TTL compatible)

device no.	function	supply voltage	output current mA	t_d max ns	packages	page
55325/75325	memory driver	+14	400	90	F, N-16	B88
75324		+7, +25	600	25	N-14	

Dual memory sense amplifiers (TTL compatible)

device no.	V_{TH} mV	V_{CM} V	output configuration	typ t_{pd} ns	features	packages	page
7520	19	± 3	common collector	20	perform as flip-flops	F, N-16	B84
7521	22						
7522	19	± 3	open collector	20	single ended output	F, N-16	B85
7523	22						
7524	19	± 2,5	common collector	25	separate outputs	F, N-16	B85
7525	22						
7528	19	± 2,5	common collector	25	output available as test points	F, N-16	B86
7529	22						
75232	19	± 2,5	open collector	25	inverted outputs	F, N-16	B86
75233	22						
75234	19	± 2,5	common collector	25	inverted outputs	F, N-16	B87
75235	22						
75S207		± 3	active pull-up	17		F, N-14	B87
75S208			open collector				

peripheral interface

abridged data

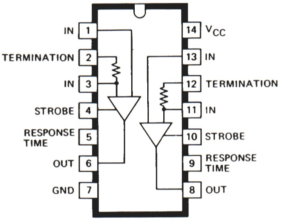
Dual line receiver DS7820/8820

Temperature range:

Military –55 °C to 125 °C DS7820F

Commercial 0 °C to 70 °C DS8820F, N

- Operates from single 5 V supply
- Response time typically 50 ns
- Input voltage range, ± 15 V
- Fan-out of 2 with DTL or TTL


IN 1
TERMINATION 2
IN 3
STROBE 4
RESPONSE TIME 5
OUT 6
GND 7
14 VCC
13 IN
12 TERMINATION
11 IN
10 STROBE
9 RESPONSE TIME
8 OUT

Package F, N-14

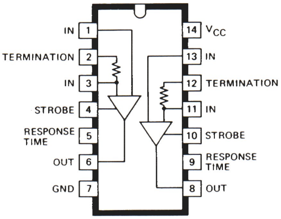
Dual line receiver DS7820A/8820A

Temperature range:

Military –55 °C to 125 °C DS7820AF

Commercial 0 °C to 70 °C DS8820AF, N

- Operates from single 5 V supply
- Response time typically 50 ns
- Input voltage range, ± 15 V
- Fan-out of 10 with DTL or TTL


IN 1
TERMINATION 2
IN 3
STROBE 4
RESPONSE TIME 5
OUT 6
GND 7
14 VCC
13 IN
12 TERMINATION
11 IN
10 STROBE
9 RESPONSE TIME
8 OUT

Package F, N-14

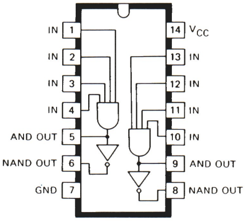
Dual differential line driver DS7830/8830

Temperature range:

Military –55 °C to 125 °C DS7830F

Commercial 0 °C to 70 °C DS8830F, N

- Operates from single 5 V supply
- Short-circuit protected outputs
- Differential propagation delay typically 12 ns


IN 1
IN 2
IN 3
IN 4
AND OUT 5
NAND OUT 6
GND 7
14 VCC
13 IN
12 IN
11 IN
10 IN
9 AND OUT
8 NAND OUT

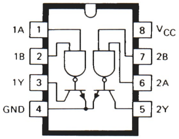
Package F, N-14

Dual AND peripheral driver DS3611

Temperature range:

Commercial 0 °C to 70 °C DS3611N

- 300 mA capability per driver
- High voltage output (80 V)
- TTL/DTL compatible
- Input clamping diodes
- Typical delay 125 ns


1A 1
1B 2
1Y 3
GND 4
8 VCC
7 2B
6 2A
5 2Y

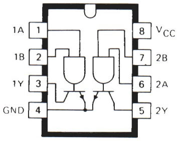
Package N

peripheral interface
abridged data

Dual NAND peripheral driver **DS3612**

Temperature range:
Commercial 0 °C to 70 °C DS3612N

- 300 mA capability per driver
- High voltage output (80 V)
- TTL/DTL compatible
- Input clamping diodes
- Typical delay 110 ns

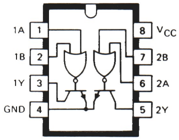

1A
1B
1Y
GND
1
2
3
4
8
7
6
5
VCC
2B
2A
2Y

Package N

Dual OR peripheral driver **DS3613**

Temperature range:
Commercial 0 °C to 70 °C DS3613N

- 300 mA capability per driver
- High voltage output (80 V)
- TTL/DTL compatible
- Input clamping diodes
- Typical delay 125 ns

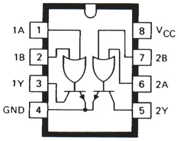

1A
1B
1Y
GND
1
2
3
4
8
7
6
5
VCC
2B
2A
2Y

Package N

Dual NOR peripheral driver **DS3614**

Temperature range:
Commercial 0 °C to 70 °C DS3614N

- 300 mA capability per driver
- High voltage output (80 V)
- TTL/DTL compatible
- Input clamping diodes
- Typical delay 150 ns

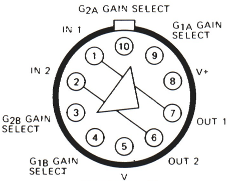

1A
1B
1Y
GND
1
2
3
4
8
7
6
5
VCC
2B
2A
2Y

Package N

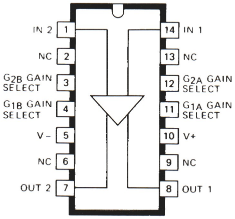
Video amplifier **μA733/733C**

Temperature range:
Military −55 °C to 125 °C μA733F, K, N
Commercial 0 °C to 70 °C μA733CF, K, N

- 120 MHz bandwidth
- Gain adjustable from 10 to 400
- No frequency compensation required


G2A GAIN SELECT
IN 1
G1A GAIN SELECT
IN 2
V+
G2B GAIN SELECT
OUT 1
G1B GAIN SELECT
OUT 2
V
1
2
3
4
5
6
7
8
9
10

Package K


IN 2
NC
G2B GAIN SELECT
G1B GAIN SELECT
V−
NC
OUT 2
1
2
3
4
5
6
7
14
13
12
11
10
9
8
IN 1
NC
G2A GAIN SELECT
G1A GAIN SELECT
V+
NC
OUT 1

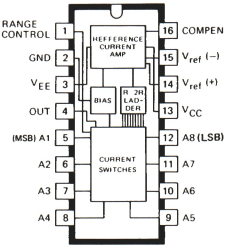
Package F, N-14

8-bit D to A converter

MC1408-8
MC1508-8

Temperature range:
Military −55 °C to 125 °C MC1508-8F, N
Commercial 0 °C to 70 °C MC1408-8F, N

- Relative accuracy ± 0,19% error(max)
- Settling time 300 ns(typ)
- Non-invert I/P TTL/CMOS compatible
- Output swing +0,5 to −5,0 V
- Multiplying input slew rate 4,0 mA/µs
- Standard supply voltages +5,0 V and −5,0 V to −15 V


RANGE CONTROL 1
GND 2
VEE 3
OUT 4
(MSB) A1 5
A2 6
A3 7
A4 8
16 COMPEN
15 Vref (−)
14 Vref (+)
13 VCC
12 A8 (LSB)
11 A7
10 A6
9 A5
REFFERENCE CURRENT AMP
BIAS
R 2R LAD-DER
CURRENT SWITCHES

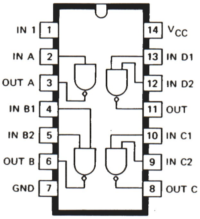
Package F, N-16

Quad line driver

MC1488

Temperature range:
Commercial 0 °C to 70 °C MC1488F, N

- Complies with CCITT recommendation V24
- Current limited output at ± 10 mA typical
- Simple slew rate control
- Typical power dissipation, 440 mW at ± 12 V


IN 1 1
IN A 2
OUT A 3
IN B1 4
IN B2 5
OUT B 6
GND 7
14 VCC
13 IN D1
12 IN D2
11 OUT
10 IN C1
9 IN C2
8 OUT C

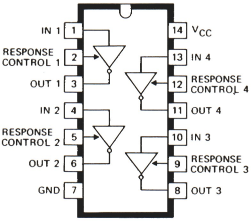
Package F, N-14

Quad line receiver

MC1489

Temperature range:
Commercial 0 °C to 75 °C MC1489F, N

- Complies with CCITT recommendation V24
- 250 mV of input hysteresis
- Typical power dissipation 100 mW


IN 1 1
RESPONSE CONTROL 1 2
OUT 1 3
IN 2 4
RESPONSE CONTROL 2 5
OUT 2 6
GND 7
14 VCC
13 IN 4
12 RESPONSE CONTROL 4
11 OUT 4
10 IN 3
9 RESPONSE CONTROL 3
8 OUT 3

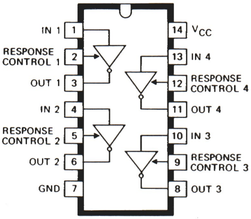
Package F, N-14

Quad line receiver

MC1489A

Temperature range:
Commercial 0 °C to 75 °C MC1489AF, N

- Complies with CCITT recommendation V24
- 1 V of input hysteresis
- Typical power dissipation 100 mW


IN 1 1
RESPONSE CONTROL 1 2
OUT 1 3
IN 2 4
RESPONSE CONTROL 2 5
OUT 2 6
GND 7
14 VCC
13 IN 4
12 RESPONSE CONTROL 4
11 OUT 4
10 IN 3
9 RESPONSE CONTROL 3
8 OUT 3

Package F, N-14

peripheral interface

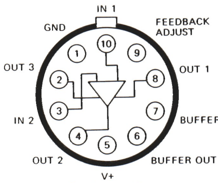
abridged data

Video amplifier NE/SE501

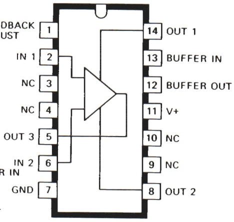
Temperature range:

Military	–55 °C to 125 °C	SE501K, N
Commercial	0 °C to 70 °C	NE501K, N

- Adjustable gain and impedance characteristics
- Unity gain frequency 150 MHz
- Typical gain 24 dB
- Bandwidth 14 MHz (–3 dB)


IN 1
GND
FEEDBACK ADJUST
OUT 3
OUT 1
IN 2
BUFFER IN
OUT 2
BUFFER OUT
V+
1
2
3
4
5
6
7
8
9
10

Package K


FEEDBACK ADJUST 1
IN 1 2
NC 3
NC 4
OUT 3 5
IN 2 6
GND 7
8 OUT 2
9 NC
10 NC
11 V+
12 BUFFER OUT
13 BUFFER IN
14 OUT 1

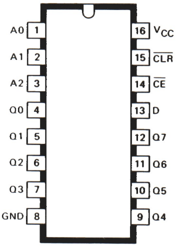
Package N-14

Peripheral driver NE590

Temperature range:

Commercial	0 °C to 70 °C	NE590F, N

- TTL compatible


A0 1
A1 2
A2 3
Q0 4
Q1 5
Q2 6
Q3 7
GND 8
9 Q4
10 Q5
11 Q6
12 Q7
13 D
14 $\overline{CE}$
15 $\overline{CLR}$
16 V_{CC}

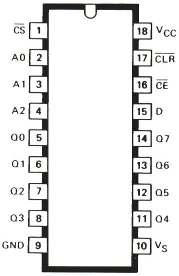
Package F, N-16

Peripheral driver NE591

Temperature range:

Commercial	0 °C to 70 °C	NE591F, N

- TTL compatible


$\overline{CS}$ 1
A0 2
A1 3
A2 4
Q0 5
Q1 6
Q2 7
Q3 8
GND 9
10 V_S
11 Q4
12 Q5
13 Q6
14 Q7
15 D
16 $\overline{CE}$
17 $\overline{CLR}$
18 V_{CC}

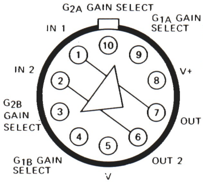
Package F, N-18

Video amplifier NE/SE592

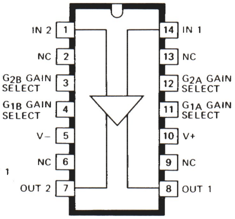
Temperature range:

Military	–55 °C to 125 °C	SE592F, K, N
Commercial	0 °C to 70 °C	NE592F, K, N

- 120 MHz bandwidth
- Gain adjustable from 0 to 400
- Suitable for high, low or bandpass filters


G_{2A} GAIN SELECT
IN 1
G_{1A} GAIN SELECT
IN 2
V+
G_{2B} GAIN SELECT
OUT 1
G_{1B} GAIN SELECT
OUT 2
V–
1
2
3
4
5
6
7
8
9
10

Package K


IN 2 1
NC 2
G_{2B} GAIN SELECT 3
G_{1B} GAIN SELECT 4
V– 5
NC 6
OUT 2 7
8 OUT 1
9 NC
10 V+
11 G_{1A} GAIN SELECT
12 G_{2A} GAIN SELECT
13 NC
14 IN 1

Package F, N-14

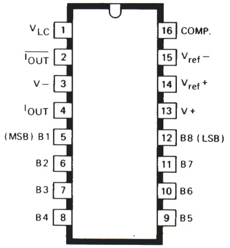
8-bit D to A converter

NE5007
NE/SE5008

Temperature range:

Military	–55 °C to 125 °C	SE5008F, N
Commercial	0 °C to 70 °C	NE5007/8F, N

- Fast settling output current 85 ns
- Full scale current pre-matched to ± 1 LSB
- Direct interface to TTL, CMOS, ECL, HTL, PMOS
- Wide power supply range ± 4,5 V to ± 18 V
- Relative accuracy to 0,1% maximum over full temp. range


V_{LC} 1
$\overline{I_{OUT}}$ 2
V– 3
I_{OUT} 4
(MSB) B1 5
B2 6
B3 7
B4 8
16 COMP.
15 V_{ref}–
14 V_{ref}+
13 V+
12 B8 (LSB)
11 B7
10 B6
9 B5

Package F, N-16

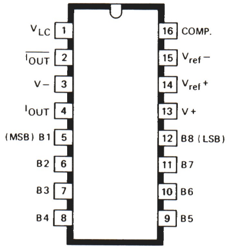
8-bit D to A converter

NE/SE5009

Temperature range:

Military	–55 °C to 125 °C	SE5009F
Commercial	0 °C to 70 °C	NE5009F, N

- Fast settling output current –60 ns typ; 135 ns max
- Relative accuracy ± 0,1% max
- Differential non-linearity ± 0,19% max
- Low scale current drift, ± 10 ppm/ °C typ


V_{LC} 1
$\overline{I_{OUT}}$ 2
V– 3
I_{OUT} 4
(MSB) B1 5
B2 6
B3 7
B4 8
16 COMP.
15 V_{ref}–
14 V_{ref}+
13 V+
12 B8 (LSB)
11 B7
10 B6
9 B5

Package F, N-16

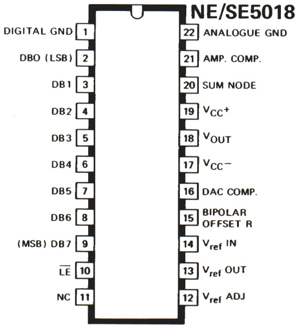
8-bit A to D converter

NE/SE5018

Temperature range:

Military	–55 °C to 125 °C	SE5018F
Commercial	0 °C to 70 °C	NE5018F, N

- 8-bit resolution
- Input latches
- Accurate to ± ½ LSB
- Amplifier and reference both short-circuit protected
- Microprocessor compatible

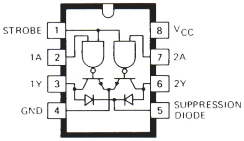

DIGITAL GND 1
DBO (LSB) 2
DB1 3
DB2 4
DB3 5
DB4 6
DB5 7
DB6 8
(MSB) DB7 9
$\overline{LE}$ 10
NC 11
22 ANALOGUE GND
21 AMP. COMP.
20 SUM NODE
19 V_{CC}+
18 V_{OUT}
17 V_{CC}–
16 DAC COMP.
15 BIPOLAR OFFSET R
14 V_{ref} IN
13 V_{ref} OUT
12 V_{ref} ADJ

Package F, N-22

Dual AND peripheral driver **UDN5711**

Temperature range:
Commercial 0 °C to 70 °C UDN5711N

- 300 mA capability per driver
- High voltage output (80 V)
- High voltage PNP inputs
- Output suppression diodes
- Input clamping diodes
- DTL/TTL compatible
- Typical delay 300 ns

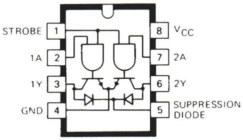

STROBE
1A
1Y
GND
1
2
3
4
8
7
6
5
VCC
2A
2Y
SUPPRESSION DIODE

Package N

Dual NAND peripheral driver **UDN5712**

Temperature range:
Commercial 0 °C to 70 °C UDN5712N

- 300 mA capability per driver
- High voltage output (80 V)
- High voltage PNP inputs
- Output suppression diodes
- Input clamping diodes
- DTL/TTL compatible
- Typical delay 300 ns

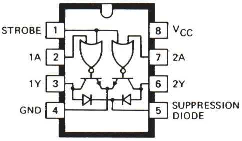

STROBE
1A
1Y
GND
1
2
3
4
8
7
6
5
VCC
2A
2Y
SUPPRESSION DIODE

Package N

Dual OR peripheral driver **UDN5713**

Temperature range:
Commercial 0 °C to 70 °C UDN5713N

- 300 mA capability per driver
- High voltage output (80 V)
- High voltage PNP inputs
- Output suppression diodes
- Input clamping diodes
- DTL/TTL compatible
- Typical delay 300 ns

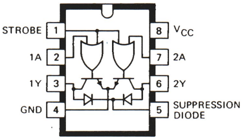

STROBE
1A
1Y
GND
1
2
3
4
8
7
6
5
VCC
2A
2Y
SUPPRESSION DIODE

Package N

Dual NOR peripheral driver **UDN5714**

Temperature range:
Commercial 0 °C to 70 °C UDN5714N

- 300 mA capability per driver
- High voltage output (80 V)
- High voltage PNP inputs
- Output suppression diodes
- Input clamping diodes
- DTL/TTL compatible
- Typical delay 300 ns


STROBE
1A
1Y
GND
1
2
3
4
8
7
6
5
VCC
2A
2Y
SUPPRESSION DIODE

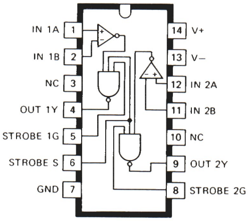
Package N

High-speed line receiver

75S107

Temperature range:
Commercial 0 °C to 70 °C 75S107F, N

- Typical offset voltage 6 mV
- 8 ns typical propagation delay
- Totem-pole outputs


IN 1A
IN 1B
NC
OUT 1Y
STROBE 1G
STROBE S
GND
1
2
3
4
5
6
7
14
13
12
11
10
9
8
V+
V−
IN 2A
IN 2B
NC
OUT 2Y
STROBE 2G

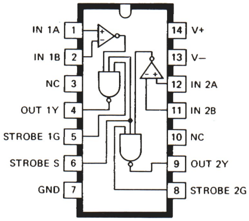
Package F, N-14

High-speed line receiver

75S108

Temperature range:
Commercial 0 °C to 70 °C 75S108F, N

- Typical offset voltage 6 mV
- 10 ns typical propagation delay
- Open-collector outputs


IN 1A
IN 1B
NC
OUT 1Y
STROBE 1G
STROBE S
GND
1
2
3
4
5
6
7
14
13
12
11
10
9
8
V+
V−
IN 2A
IN 2B
NC
OUT 2Y
STROBE 2G

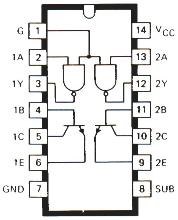
Package F, N-14

Dual peripheral driver

75450B

Temperature range:
Commercial 0 °C to 70 °C 75450BF, N

- Dual NAND function plus uncommitted transistors
- 30 V and 300 mA output rating
- Typical delay 20 ns


G
1A
1Y
1B
1C
1E
GND
1
2
3
4
5
6
7
14
13
12
11
10
9
8
VCC
2A
2Y
2B
2C
2E
SUB

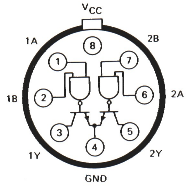
Package F, N-14

Dual peripheral driver

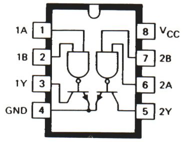
75451B

Temperature range:
Commercial 0 °C to 70 °C **75451BF, N, T**

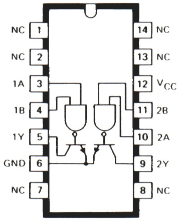
- Dual AND function
- 30 V and 300 mA output rating
- Typical delay 20 ns


VCC
1A
2B
8
1
7
1B
2
6
2A
3
5
4
1Y
2Y
GND

Package T


1A 1
1B 2
1Y 3
GND 4
8 VCC
7 2B
6 2A
5 2Y

Package N


NC 1
NC 2
1A 3
1B 4
1Y 5
GND 6
NC 7
14 NC
13 NC
12 VCC
11 2B
10 2A
9 2Y
8 NC

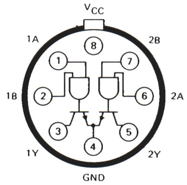
Package F

Dual peripheral driver

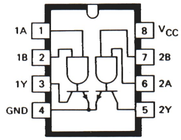
75452B

Temperature range:
Commercial 0 °C to 70 °C **75452BF, N, T**

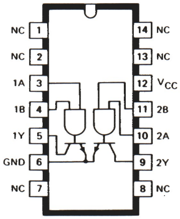
- Dual NAND function
- 30 V and 300 mA output rating
- Typical delay 20 ns


VCC
1A
2B
8
1
7
1B
2
6
2A
3
5
4
1Y
2Y
GND

Package T


1A 1
1B 2
1Y 3
GND 4
8 VCC
7 2B
6 2A
5 2Y

Package N


NC 1
NC 2
1A 3
1B 4
1Y 5
GND 6
NC 7
14 NC
13 NC
12 VCC
11 2B
10 2A
9 2Y
8 NC

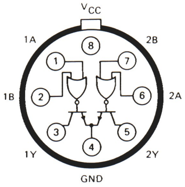
Package F

Dual peripheral driver

75453B

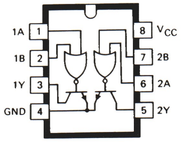
Temperature range:
Commercial 0 °C to 70 °C 75453BF, N, T

- Dual OR function
- 30 V and 300 mA output rating
- Typical delay 20 ns



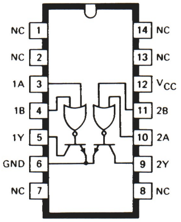
VCC
1A
2B
1B
2A
1Y
2Y
GND
1
2
3
4
5
6
7
8

Package T



1A 1
1B 2
1Y 3
GND 4
8 VCC
7 2B
6 2A
5 2Y

Package N



NC 1
NC 2
1A 3
1B 4
1Y 5
GND 6
NC 7
14 NC
13 NC
12 VCC
11 2B
10 2A
9 2Y
8 NC

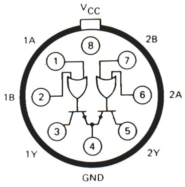
Package F

Dual peripheral driver

75454B

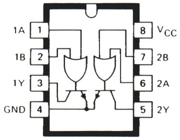
Temperature range:
Commercial 0 °C to 70 °C 75454BF, N, T

- Dual NOR function
- 30 V and 300 mA output rating
- Typical delay 20 ns



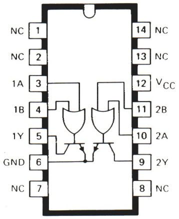
VCC
1A
2B
1B
2A
1Y
2Y
GND
1
2
3
4
5
6
7
8

Package T



1A 1
1B 2
1Y 3
GND 4
8 VCC
7 2B
6 2A
5 2Y

Package N



NC 1
NC 2
1A 3
1B 4
1Y 5
GND 6
NC 7
14 NC
13 NC
12 VCC
11 2B
10 2A
9 2Y
8 NC

Package F

For other transistor array requirements contact us — see back cover for address.

General purpose NPN transistor array

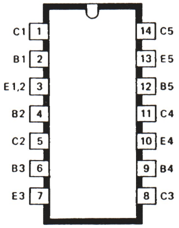
CA3045

General purpose NPN transistor array

CA3046
CA3086

Temperature range:
Military −40 °C to 125 °C CA3046N, CA3086N

- 3 single transistors
- 2 common emitter transistors
- V_{CEO} 35 V
- V_{CBO} 50 V
- V_{EBO} 6 V
- V_{CEsat} 0,4 V


C1 1
B1 2
E1,2 3
B2 4
C2 5
B3 6
E3 7
14 C5
13 E5
12 B5
11 C4
10 E4
9 B4
8 C3

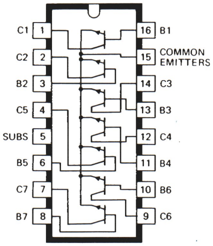
Package N-14

General purpose NPN transistor array

CA3081

Temperature range:
Military −55 °C to 125 °C CA3081N

- Current 100 mA(max)
- V_{CEsat} 0,4 V at 50 mA(typ)
- V_{CEO} 16 V(max)
- V_{CBO} 20 V(max)
- V_{EBO} 5 V(max)
- Common emitter


C1 1
C2 2
B2 3
C5 4
SUBS 5
B5 6
C7 7
B7 8
16 B1
15 COMMON EMITTERS
14 C3
13 B3
12 C4
11 B4
10 B6
9 C6

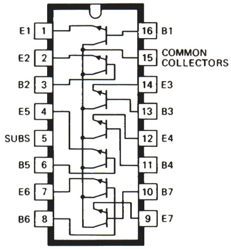
Package N-16

General purpose NPN transistor array

CA3082

Temperature range:
Military −55 °C to 125 °C CA3082N

- Current 100 mA(max)
- V_{CEsat} 0,4 V at 50 mA(typ)
- V_{CEO} 16 V(max)
- V_{CBO} 20 V(max)
- V_{EBO} 5 V(max)
- Common collector


E1 1
E2 2
B2 3
E5 4
SUBS 5
B5 6
E6 7
B6 8
16 B1
15 COMMON COLLECTORS
14 E3
13 B3
12 E4
11 B4
10 B7
9 E7

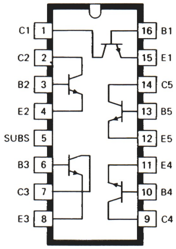
Package N-16

General purpose NPN transistor array

CA3083

Temperature range:
Military −55 °C to 125 °C CA3083N

- Current 100 mA(max)
- V_{CEsat} 0,4 V at 50 mA(typ)
- V_{CEO} 16 V(max)
- V_{CBO} 20 V(max)
- V_{EBO} 5 V(max)


C1 1
C2 2
B2 3
E2 4
SUBS 5
B3 6
C3 7
E3 8
16 B1
15 E1
14 C5
13 B5
12 E5
11 E4
10 B4
9 C4

Package N-16

General purpose NPN transistor array

CA3183

display interface

abridged data

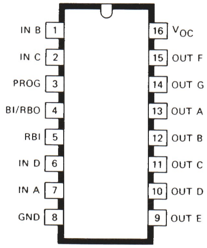
7-segment decoder/driver

DS8880

Temperature range:

Commercial	0 °C to 70 °C	DS8880N

- Directly drives high voltage gas discharge displays
- Ripple blanking facility
- TTL compatible inputs
- 135 mW typical power dissipation


IN B 1
IN C 2
PROG 3
BI/RBO 4
RBI 5
IN D 6
IN A 7
GND 8
16 V_{OC}
15 OUT F
14 OUT G
13 OUT A
12 OUT B
11 OUT C
10 OUT D
9 OUT E

Package F, N-16

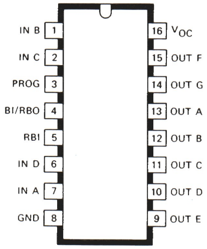
7-segment decoder/driver

DS8880-1

Temperature range:

Commercial	0 °C to 70 °C	DS8880-1F, N

- Directly drives high voltage gas discharge displays
- Ripple blanking facility
- TTL compatible inputs
- 135 mW typical power dissipation
- 100 V interface


IN B 1
IN C 2
PROG 3
BI/RBO 4
RBI 5
IN D 6
IN A 7
GND 8
16 V_{OC}
15 OUT F
14 OUT G
13 OUT A
12 OUT B
11 OUT C
10 OUT D
9 OUT E

Package F, N-16

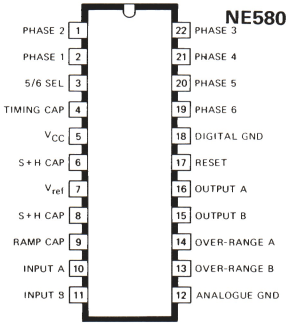
Bar-graph driver

NE580

Temperature range:

Commercial	0 °C to 70 °C	NE580F, N

- Dual channel device
- Easily expandable to handle more channels
- Single 5 V supply
- 3, 5 or 6-phase operation
- Can be custom masked for different cathode segment counts (max 240)
- Overrange indication outputs


PHASE 2 1
PHASE 1 2
5/6 SEL 3
TIMING CAP 4
V_{CC} 5
S+H CAP 6
V_{ref} 7
S+H CAP 8
RAMP CAP 9
INPUT A 10
INPUT B 11
22 PHASE 3
21 PHASE 4
20 PHASE 5
19 PHASE 6
18 DIGITAL GND
17 RESET
16 OUTPUT A
15 OUTPUT B
14 OVER-RANGE A
13 OVER-RANGE B
12 ANALOGUE GND

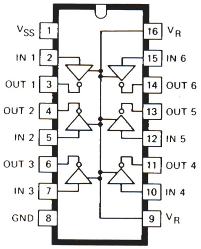
Package F, N-22

Hex universal driver

NE582

Temperature range:
Commercial 0 °C to 70 °C NE582F, N

- Low saturation voltage 0,5 V(typ)
- Output sink capability
  - each output 400 mA
  - all outputs 1200 mA
- Low input current loading
- Suitable for 3 V battery operation



V_{SS} 1
IN 1 2
OUT 1 3
OUT 2 4
IN 2 5
OUT 3 6
IN 3 7
GND 8
9 V_R
10 IN 4
11 OUT 4
12 IN 5
13 OUT 5
14 OUT 6
15 IN 6
16 V_R

Package F, N-16

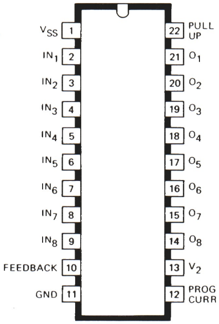
Gas discharge cathode driver

NE584

Temperature range:
Commercial 0 °C to 70 °C NE584F, N

- Segment current programmability up to 5 mA
- Integral current limiting
- Minimum component count for system cost effectiveness
- Internal feedback network
- High output breakdown 90 V
- Internal output pull-up
- 8 or 9 segment versions

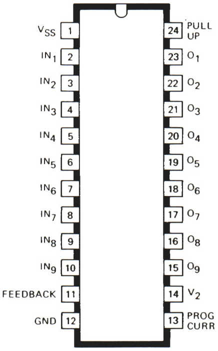
NE584-8



V_{SS} 1
IN_1 2
IN_2 3
IN_3 4
IN_4 5
IN_5 6
IN_6 7
IN_7 8
IN_8 9
FEEDBACK 10
GND 11
12 PROG CURR
13 V_2
14 O_8
15 O_7
16 O_6
17 O_5
18 O_4
19 O_3
20 O_2
21 O_1
22 PULL UP

Package F, N-22

NE584-9



V_{SS} 1
IN_1 2
IN_2 3
IN_3 4
IN_4 5
IN_5 6
IN_6 7
IN_7 8
IN_8 9
IN_9 10
FEEDBACK 11
GND 12
13 PROG CURR
14 V_2
15 O_9
16 O_8
17 O_7
18 O_6
19 O_5
20 O_4
21 O_3
22 O_2
23 O_1
24 PULL UP

Package F, N-24

display interface

abridged data

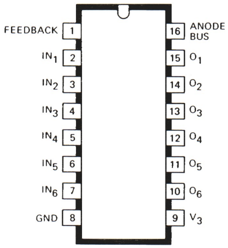
Gas discharge anode driver

NE585

Temperature range:
Commercial 0 °C to 70 °C NE585F, N

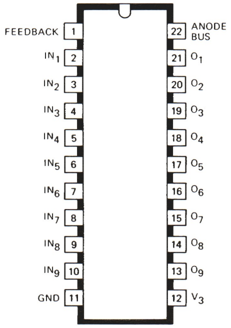
- Segment current programmability
- Internal current limiting
- Minimum component count for system cost effectiveness
- Internal feedback network
- Automatic loop control of firing voltage
- 6 or 9 digit versions
- High output breakdown 90 V
- Internal output pull-down

NE585-6


FEEDBACK 1
IN1 2
IN2 3
IN3 4
IN4 5
IN5 6
IN6 7
GND 8
16 ANODE BUS
15 O1
14 O2
13 O3
12 O4
11 O5
10 O6
9 V3

Package F, N-16

NE585-9


FEEDBACK 1
IN1 2
IN2 3
IN3 4
IN4 5
IN5 6
IN6 7
IN7 8
IN8 9
IN9 10
GND 11
22 ANODE BUS
21 O1
20 O2
19 O3
18 O4
17 O5
16 O6
15 O7
14 O8
13 O9
12 V3

Package F, N-22

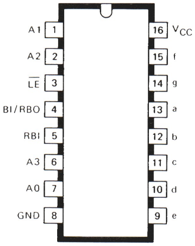
LED drivers

NE586 to 589

Temperature range:
Commercial 0 °C to 70 °C NE586 to 589F, N

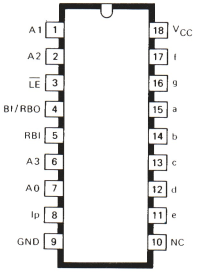
- Input microprocessor compatible
- NE586, NE588 fixed current
- NE587, NE589 current programmable
- NE586, NE587 current sinking outputs
- NE588, NE589 current sourcing outputs

NE586; NE588


A1 1
A2 2
LE 3
BI/RBO 4
RBI 5
A3 6
A0 7
GND 8
16 VCC
15 f
14 g
13 a
12 b
11 c
10 d
9 e

Package F, N-16

NE587; NE589

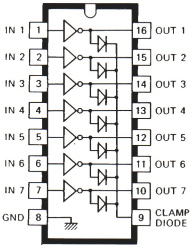

A1 1
A2 2
LE 3
BI/RBO 4
RBI 5
A3 6
A0 7
Ip 8
GND 9
18 VCC
17 f
16 g
15 a
14 b
13 c
12 d
11 e
10 NC

Package F, N-18

Darlington transistor array **NE5501**

Temperature range:
Commercial 0 °C to 85 °C NE5501N

- High current 350 mA(max)
- V_{CEsat} 1,6 V at 350 mA(max)
- Output breakdown voltage 100 V(min)
- Input voltage V_{IN} 30 V(max)

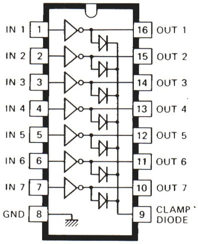

IN 1
1
16
OUT 1
IN 2
2
15
OUT 2
IN 3
3
14
OUT 3
IN 4
4
13
OUT 4
IN 5
5
12
OUT 5
IN 6
6
11
OUT 6
IN 7
7
10
OUT 7
GND
8
9
CLAMP DIODE

Package N-16

Darlington transistor array **NE5502**

Temperature range:
Commercial 0 °C to 85 °C NE5502N

- High current 350 mA(max)
- V_{CEsat} 1,6 V at 350 mA(max)
- Output breakdown voltage 100 V(min)
- Input voltage V_{IN} 30 V(max)
- Each input has zener diode and resistor current limiting

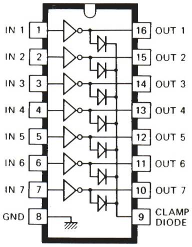

IN 1
1
16
OUT 1
IN 2
2
15
OUT 2
IN 3
3
14
OUT 3
IN 4
4
13
OUT 4
IN 5
5
12
OUT 5
IN 6
6
11
OUT 6
IN 7
7
10
OUT 7
GND
8
9
CLAMP DIODE

Package N-16

Darlington transistor array **NE5503**

Temperature range:
Commercial 0 °C to 85 °C NE5503N

- High current 350 mA(max)
- V_{CEsat} 1,6 V at 350 mA(max)
- Output breakdown voltage 100 V(min)
- Input voltage V_{IN} 30 V(max)
- Each input has series resistor

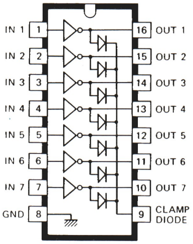

IN 1
1
16
OUT 1
IN 2
2
15
OUT 2
IN 3
3
14
OUT 3
IN 4
4
13
OUT 4
IN 5
5
12
OUT 5
IN 6
6
11
OUT 6
IN 7
7
10
OUT 7
GND
8
9
CLAMP DIODE

Package N-16

Darlington transistor array **NE5504**

Temperature range:
Commercial 0 °C to 85 °C NE5504N

- High current 350 mA(max)
- V_{CEsat} 1,6 V at 350 mA(max)
- Output breakdown voltage 100 V(min)
- Input voltage V_{IN} 30 V(max)
- Each input has series resistor


IN 1
1
16
OUT 1
IN 2
2
15
OUT 2
IN 3
3
14
OUT 3
IN 4
4
13
OUT 4
IN 5
5
12
OUT 5
IN 6
6
11
OUT 6
IN 7
7
10
OUT 7
GND
8
9
CLAMP DIODE

Package N-16

memory interface

abridged data

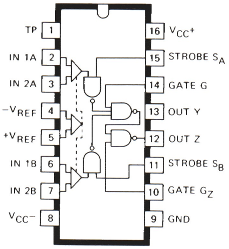
Dual core sense amp

7520

Temperature range:

Commercial 0 °C to 70 °C 7520F, N

- Typical propagation delay 25 ns
- Complementary outputs with strobes
- No external stabilizing capacitor necessary
- ± 4 mV threshold uncertainty


TP 1
IN 1A 2
IN 2A 3
$-V_{REF}$ 4
$+V_{REF}$ 5
IN 1B 6
IN 2B 7
$V_{CC}-$ 8
16 $V_{CC}+$
15 STROBE S_A
14 GATE G
13 OUT Y
12 OUT Z
11 STROBE S_B
10 GATE G_Z
9 GND

Package F, N-16

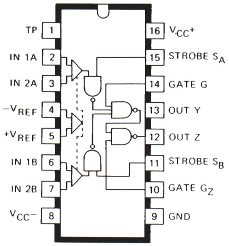
Dual core sense amp

7521

Temperature range:

Commercial 0 °C to 70 °C 7521F, N

- Typical propagation delay 25 ns
- Complementary outputs with strobes
- No external stabilizing capacitor necessary
- ± 7 mV thresehold uncertainty


TP 1
IN 1A 2
IN 2A 3
$-V_{REF}$ 4
$+V_{REF}$ 5
IN 1B 6
IN 2B 7
$V_{CC}-$ 8
16 $V_{CC}+$
15 STROBE S_A
14 GATE G
13 OUT Y
12 OUT Z
11 STROBE S_B
10 GATE G_Z
9 GND

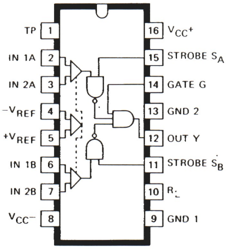
Package F, N-16

Dual core sense amp

7522

Temperature range:
Commercial 0 °C to 70 °C 7522F, N

- Typical propagation delay 25 ns
- Open collector output
- No external stabilizing capacitor necessary
- ± 4 mV threshold uncertainty



TP 1
IN 1A 2
IN 2A 3
$-V_{REF}$ 4
$+V_{REF}$ 5
IN 1B 6
IN 2B 7
V_{CC}^{-} 8
16 V_{CC}^{+}
15 STROBE S_A
14 GATE G
13 GND 2
12 OUT Y
11 STROBE S_B
10 R_L
9 GND 1

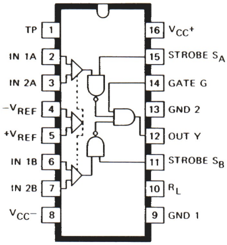
Package F, N-16

Dual core sense amp

7523

Temperature range:
Commercial 0 °C to 70 °C 7523F, N

- Typical propagation delay 25 ns
- Open collector output
- No external stabilizing capacitor necessary
- ± 7 mV threshold uncertainty



TP 1
IN 1A 2
IN 2A 3
$-V_{REF}$ 4
$+V_{REF}$ 5
IN 1B 6
IN 2B 7
V_{CC}^{-} 8
16 V_{CC}^{+}
15 STROBE S_A
14 GATE G
13 GND 2
12 OUT Y
11 STROBE S_B
10 R_L
9 GND 1

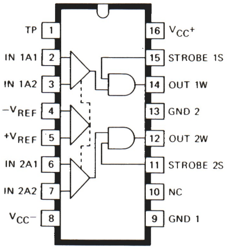
Package F, N-16

Dual core sense amp

7524

Temperature range:
Commercial 0 °C to 70 °C 7524F, N

- Typical propagation delay 25 ns
- Independent outputs with gating
- No external stabilizing capacitor necessary
- ± 4 mV threshold uncertainty



TP 1
IN 1A1 2
IN 1A2 3
$-V_{REF}$ 4
$+V_{REF}$ 5
IN 2A1 6
IN 2A2 7
V_{CC}^{-} 8
16 V_{CC}^{+}
15 STROBE 1S
14 OUT 1W
13 GND 2
12 OUT 2W
11 STROBE 2S
10 NC
9 GND 1

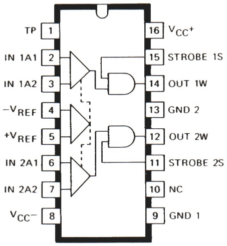
Package F, N-16

Dual core sense amp

7525

Temperature range:
Commercial 0 °C to 70 °C 7525F, N

- Typical propagation delay 25 ns
- Independent outputs with gating
- No external stabilizing capacitor necessary
- ± 7 mV threshold uncertainty



TP 1
IN 1A1 2
IN 1A2 3
$-V_{REF}$ 4
$+V_{REF}$ 5
IN 2A1 6
IN 2A2 7
V_{CC}^{-} 8
16 V_{CC}^{+}
15 STROBE 1S
14 OUT 1W
13 GND 2
12 OUT 2W
11 STROBE 2S
10 NC
9 GND 1

Package F, N-16

memory interface

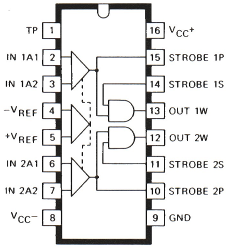
abridged data

Dual core sense amp

7528

Temperature range;
Commercial 0 °C to 70 °C 7528F, N

- Typical propagation delay 25 ns
- Independent outputs with gating
- No external stabilizing capacitor necessary
- Amplifier output available as a test point
- ± 4 mV threshold uncertainty



TP 1
IN 1A1 2
IN 1A2 3
−VREF 4
+VREF 5
IN 2A1 6
IN 2A2 7
VCC− 8
16 VCC+
15 STROBE 1P
14 STROBE 1S
13 OUT 1W
12 OUT 2W
11 STROBE 2S
10 STROBE 2P
9 GND

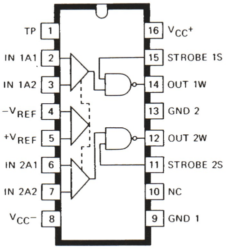
Package F, N-16

Dual core sense amp

75232

Temperature range:
Commercial 0 °C to 70 °C 75232F, N

- Typical propagation delay 25 ns
- Independent outputs with gating
- No external stabilizing capacitor necessary
- Open collector output
- ± 4 mV threshold uncertainty



TP 1
IN 1A1 2
IN 1A2 3
−VREF 4
+VREF 5
IN 2A1 6
IN 2A2 7
VCC− 8
16 VCC+
15 STROBE 1S
14 OUT 1W
13 GND 2
12 OUT 2W
11 STROBE 2S
10 NC
9 GND 1

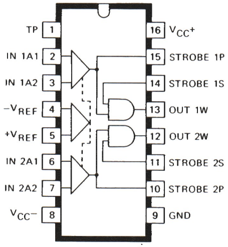
Package F, N-16

Dual core sense amp

7529

Temperature range:
Commercial 0 °C to 70 °C 7529F, N

- Typical propagation delay 25 ns
- Independent outputs with gating
- No external stabilizing capacitor necessary
- Amplifier output available as a test point
- ± 7 mV threshold uncertainty



TP 1
IN 1A1 2
IN 1A2 3
−VREF 4
+VREF 5
IN 2A1 6
IN 2A2 7
VCC− 8
16 VCC+
15 STROBE 1P
14 STROBE 1S
13 OUT 1W
12 OUT 2W
11 STROBE 2S
10 STROBE 2P
9 GND

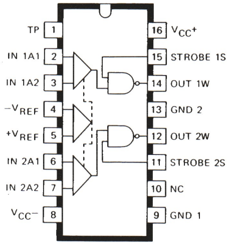
Package F, N-16

Dual core sense amp

75233

Temperature range:
Commercial 0 °C to 70 °C 75233F, N

- Typical propagation delay 25 ns
- Independent outputs with gating
- No external stabilizing capacitor necessary
- Open collector output
- ± 7 mV threshold uncertainty



TP 1
IN 1A1 2
IN 1A2 3
−VREF 4
+VREF 5
IN 2A1 6
IN 2A2 7
VCC− 8
16 VCC+
15 STROBE 1S
14 OUT 1W
13 GND 2
12 OUT 2W
11 STROBE 2S
10 NC
9 GND 1

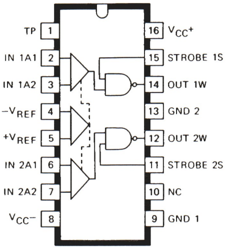
Package F, N-16

Dual core sense amp

75234

Temperature range:
Commercial 0 °C to 70 °C 75234F, N

- Typical propagation delay 25 ns
- Independent outputs with gating
- No external stabilizing capacitor necessary
- ± 4 mV threshold uncertainty


TP 1
IN 1A1 2
IN 1A2 3
$-V_{REF}$ 4
$+V_{REF}$ 5
IN 2A1 6
IN 2A2 7
$V_{CC}-$ 8
16 $V_{CC}+$
15 STROBE 1S
14 OUT 1W
13 GND 2
12 OUT 2W
11 STROBE 2S
10 NC
9 GND 1

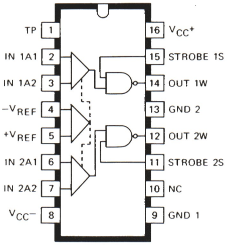
Package F, N-16

Dual core sense amp

75235

Temperature range:
Commercial 0 °C to 70 °C 75235F, N

- Typical propagation delay 25 ns
- Independent outputs with gating
- No external stabilizing capacitor necessary
- ± 7 mV threshold uncertainty


TP 1
IN 1A1 2
IN 1A2 3
$-V_{REF}$ 4
$+V_{REF}$ 5
IN 2A1 6
IN 2A2 7
$V_{CC}-$ 8
16 $V_{CC}+$
15 STROBE 1S
14 OUT 1W
13 GND 2
12 OUT 2W
11 STROBE 2S
10 NC
9 GND 1

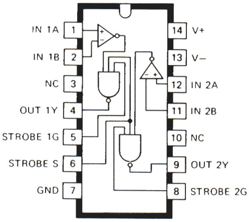
Package F, N-16

High-speed dual sense amp

75S207

Temperature range:
Commercial 0 °C to 70 °C 75S207F, N

- 17 ns guaranteed propagation delay
- 20 μA(max) input bias current
- STTL compatible strobes and outputs
- Large common mode input voltage range
- Standard supply voltages
- Function and pin compatible with SN75207


IN 1A 1
IN 1B 2
NC 3
OUT 1Y 4
STROBE 1G 5
STROBE S 6
GND 7
14 V+
13 V−
12 IN 2A
11 IN 2B
10 NC
9 OUT 2Y
8 STROBE 2G

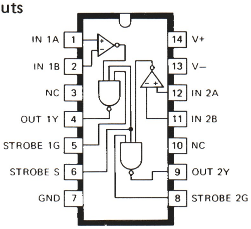
Package F, N-14

High-speed dual sense amp

75S208

Temperature range:
Commercial 0 °C to 70 °C 75S208F, N

- 17 ns guaranteed propagation delay
- 20 μA(max) input bias current
- STTL compatible strobes and outputs
- Large common mode input voltage range
- Standard supply voltages
- Function and pin compatible with SN75208
- Open collector outputs


IN 1A 1
IN 1B 2
NC 3
OUT 1Y 4
STROBE 1G 5
STROBE S 6
GND 7
14 V+
13 V−
12 IN 2A
11 IN 2B
10 NC
9 OUT 2Y
8 STROBE 2G

Package F, N-14

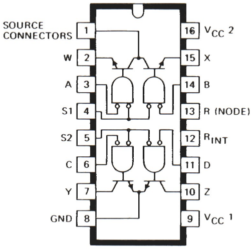
memory interface

abridged data

Memory driver 55325/75325

Temperature range:
Military −55 °C to 125 °C 55325F
Commercial 0 °C to 70 °C 75325F, N

- 600 mA output capability
- Propagation delays 25 ns(typ)
- Output short-circuit protected
- Dual sink and source outputs
- Minimum time skew between address and output current rise
- 24 V output capability

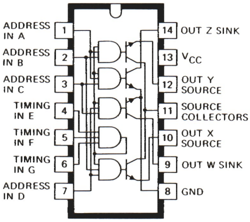

SOURCE CONNECTORS
1
W
2
A
3
S1
4
S2
5
C
6
Y
7
GND
8
16
VCC 2
15
X
14
B
13
R (NODE)
12
RINT
11
D
10
Z
9
VCC 1

Package F, N-16

Memory driver 75324

Temperature range:
Commercial 0 °C to 70 °C 75324N

- 400 mA output capability
- Internal decoding and timing
- Output short-circuit protection
- Dual sink/source outputs


ADDRESS IN A
1
ADDRESS IN B
2
ADDRESS IN C
3
TIMING IN E
4
TIMING IN F
5
TIMING IN G
6
ADDRESS IN D
7
14
OUT Z SINK
13
VCC
12
OUT Y SOURCE
11
SOURCE COLLECTORS
10
OUT X SOURCE
9
OUT W SINK
8
GND

Package N-14

telecommunications

survey

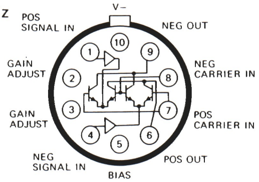
		page
MC1496/1596	Double balanced mixer/modulator	B90
NE503	Bucket brigade delay line	
NE504	Bucket brigade delay line	
NE/SE560	Phase locked loop	B91
NE/SE561	Phase locked loop	
NE/SE562	Phase locked loop	
NE/SE564	Digital phase locked loop	
NE/SE565	Phase locked loop	B92
NE/SE566	Function generator	
NE/SE567	Tone decoder	
NE570	Analogue compandor	B93
NE571	Analogue compandor	
NE575	Phase locked loop	
NE593	Sextuple latch	B94
NE/SE5596	Double balanced mixer/modulator	
SD5000	Quad analogue S.P.S.T. switch	
SD5001	Quad analogue S.P.S.T. switch	B95
SD5002	30 V driver circuit	
SD5100	Four channel multiplexer	
SD5101	Four channel multiplexer	
SD5200	Quad analogue S.P.S.T. driver	B96
SD5301	Cross point switch	
TAA960	Triple amp	
TAA970	Microphone amp	
TBA673	Ring modulator	B97
TBA915	Low power audio amp	
TCA210	Low power audio amp	
TCA240	Double balanced mixer/modulator	
TCA580	Gyrator	B98
TCA770A	IF limiter amp	
TCA980	Microphone amp	
TDA1022; NE502	Bucket brigade delay line	

Double balanced mixer/modulator

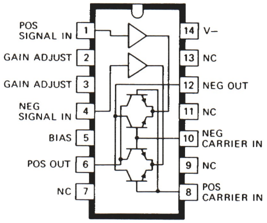
MC1496/1596

Temperature range:
Military −55 °C to 125 °C MC1596F, K, N
Commercial 0 °C to 70 °C MC1496F, K, N

- Carrier suppression 65 dB typical at 0,5 MHz
- Common mode rejection 85 dB


V−
POS SIGNAL IN
NEG OUT
GAIN ADJUST
NEG CARRIER IN
GAIN ADJUST
POS CARRIER IN
NEG SIGNAL IN
POS OUT
BIAS
1
2
3
4
5
6
7
8
9
10

Package K


POS SIGNAL IN 1
GAIN ADJUST 2
GAIN ADJUST 3
NEG SIGNAL IN 4
BIAS 5
POS OUT 6
NC 7
14 V−
13 NC
12 NEG OUT
11 NC
10 NEG CARRIER IN
9 NC
8 POS CARRIER IN

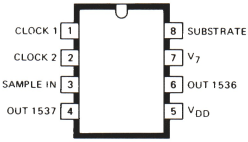
Package F, N-14

Bucket brigade delay line

NE503

Temperature range:
Industrial −20 °C to 85 °C NE503N

- Clock frequency 5-100 kHz
- 1536 buckets
- Signal delay 153,6 μs → 7,68 ms
- Attenuation 0 dB


CLOCK 1 1
CLOCK 2 2
SAMPLE IN 3
OUT 1537 4
8 SUBSTRATE
7 V_7
6 OUT 1536
5 V_{DD}

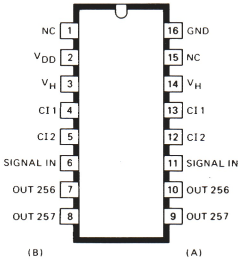
Package N

Bucket brigade delay line

NE504

Temperature range:
Industrial −20 °C to 85 °C NE504N

- Clock frequency 5-500 kHz
- 2 x 256 buckets
- Signal delay 256 μs – 25,6 ms
- Attenuation 3,5 dB


NC 1
V_{DD} 2
V_H 3
CI 1 4
CI 2 5
SIGNAL IN 6
OUT 256 7
OUT 257 8
16 GND
15 NC
14 V_H
13 CI 1
12 CI 2
11 SIGNAL IN
10 OUT 256
9 OUT 257
(B)
(A)

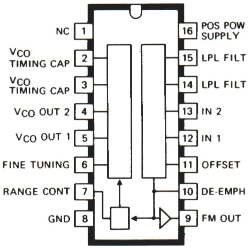
Package N-16

Phase locked loop NE/SE560

Temperature range:

Military	−55 °C to 125 °C	SE560F
Commercial	0 °C to 70 °C	NE560F, N

- FM demodulation without tuned circuits
- Bandpass adjustable down to ± 1%
- Operating frequency up to 30 MHz typical


NC 1
VCO TIMING CAP 2
VCO TIMING CAP 3
VCO OUT 2 4
VCO OUT 1 5
FINE TUNING 6
RANGE CONT 7
GND 8
16 POS POW SUPPLY
15 LPL FILT
14 LPL FILT
13 IN 2
12 IN 1
11 OFFSET
10 DE-EMPH
9 FM OUT

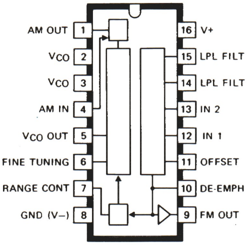
Package F, N-16

Phase locked loop NE/SE561

Temperature range:

Military	−55 °C to 125 °C	SE561F
Commercial	0 °C to 70 °C	NE561F, N

- FM demodulation without tuned circuits
- Synchronous AM detection
- Operating frequency up to 30 MHz typical


AM OUT 1
VCO 2
VCO 3
AM IN 4
VCO OUT 5
FINE TUNING 6
RANGE CONT 7
GND (V−) 8
16 V+
15 LPL FILT
14 LPL FILT
13 IN 2
12 IN 1
11 OFFSET
10 DE-EMPH
9 FM OUT

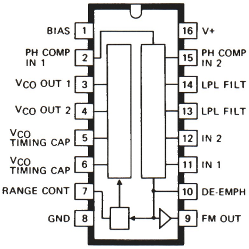
Package F, N-16

Phase locked loop NE/SE562

Temperature range:

Military	−55 °C to 125 °C	SE562F
Commercial	0 °C to 70 °C	NE562F, N

- FM demodulation without tuned circuits
- Frequency multiplication and division
- Operating frequency up to 30 MHz typical


BIAS 1
PH COMP IN 1 2
VCO OUT 1 3
VCO OUT 2 4
VCO TIMING CAP 5
VCO TIMING CAP 6
RANGE CONT 7
GND 8
16 V+
15 PH COMP IN 2
14 LPL FILT
13 LPL FILT
12 IN 2
11 IN 1
10 DE-EMPH
9 FM OUT

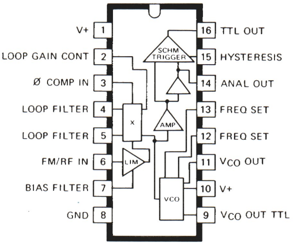
Package F, N-16

Phase locked loop NE/SE564

Temperature range:

Military	−55 °C to 125 °C	SE564F
Commercial	0 °C to 70 °C	NE564F, N

- Operation with 5 V supply
- TTL compatible inputs/outputs
- Reduced carrier feed-through
- External loop gain control
- Operation to 50 MHz


V+ 1
LOOP GAIN CONT 2
Ø COMP IN 3
LOOP FILTER 4
LOOP FILTER 5
FM/RF IN 6
BIAS FILTER 7
GND 8
16 TTL OUT
15 HYSTERESIS
14 ANAL OUT
13 FREQ SET
12 FREQ SET
11 VCO OUT
10 V+
9 VCO OUT TTL
SCHM TRIGGER
X
AMP
LIM
VCO

Package F, N-16

telecommunications

abridged data

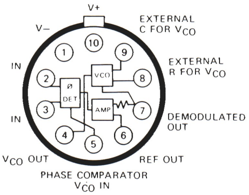
Phase locked loop

NE/SE565

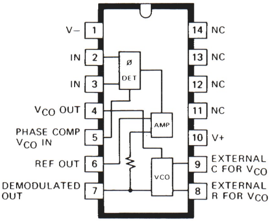
Temperature range:

Military	–55 °C to 125 °C	SE565K
Commercial	0 °C to 70 °C	NE565K, N

- Frequency range 0,001 Hz to 500 kHz
- High linearity of demodulated output, 0,2% typical
- Bandpass adjustable from ± 1% to ± 60%


V+
V–
EXTERNAL C FOR V_{CO}
IN
EXTERNAL R FOR V_{CO}
IN
DEMODULATED OUT
V_{CO} OUT
REF OUT
PHASE COMPARATOR V_{CO} IN
1
2
3
4
5
6
7
8
9
10
ø DET
VCO
AMP

Package K


V–
IN
IN
V_{CO} OUT
PHASE COMP V_{CO} IN
REF OUT
DEMODULATED OUT
1
2
3
4
5
6
7
14
13
12
11
10
9
8
NC
NC
NC
NC
V+
EXTERNAL C FOR V_{CO}
EXTERNAL R FOR V_{CO}
ø DET
AMP
VCO

Package N-14

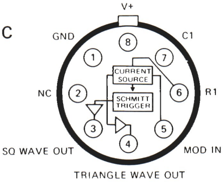
Function generator

NE/SE566

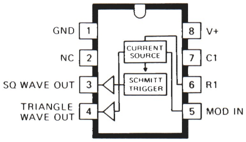
Temperature range:

Military	–55 °C to 125 °C	SE566T
Commercial	0 °C to 70 °C	NE566N, T

- High linear triangle wave output
- Temperature stability typically 200 ppm/°C
- Frequency range from 0,01 Hz to 1 MHz


V+
GND
C1
NC
R1
SQ WAVE OUT
MOD IN
TRIANGLE WAVE OUT
1
2
3
4
5
6
7
8
CURRENT SOURCE
SCHMITT TRIGGER

Package T


GND
NC
SQ WAVE OUT
TRIANGLE WAVE OUT
1
2
3
4
8
7
6
5
V+
C1
R1
MOD IN
CURRENT SOURCE
SCHMITT TRIGGER

Package N

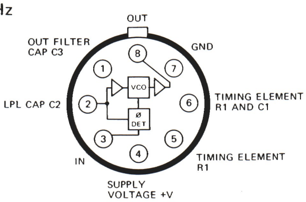
Tone decoder

NE/SE567

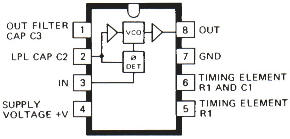
Temperature range:

Military	–55 °C to 125 °C	SE567T
Commercial	0 °C to 70 °C	NE567N, T

- Wide frequency range 0,01 Hz to 500 KHz
- Independently controlled bandwidth, up to 14%
- Logic compatible open collector output


OUT
OUT FILTER CAP C3
GND
LPL CAP C2
TIMING ELEMENT R1 AND C1
IN
TIMING ELEMENT R1
SUPPLY VOLTAGE +V
1
2
3
4
5
6
7
8
VCO
ø DET

Package T


OUT FILTER CAP C3
LPL CAP C2
IN
SUPPLY VOLTAGE +V
1
2
3
4
8
7
6
5
OUT
GND
TIMING ELEMENT R1 AND C1
TIMING ELEMENT R1
VCO
ø DET

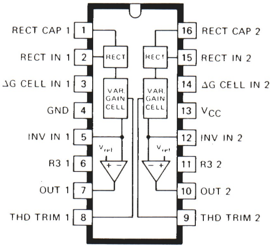
Package N

Analogue compandor

NE570

Temperature range:
Industrial –40 °C to 70 °C NE570F, N

- Complete IC compressor expandor
- 110 dB dynamic range
- Operates down to 6 V
- Typical noise 15 μV
- Full audio bandwidth


RECT CAP 1
1
RECT IN 1
2
ΔG CELL IN 1
3
GND
4
INV IN 1
5
R3 1
6
OUT 1
7
THD TRIM 1
8
RECT
VAR GAIN CELL
Vref
+ −
− +
16
RECT CAP 2
15
RECT IN 2
14
ΔG CELL IN 2
13
VCC
12
INV IN 2
11
R3 2
10
OUT 2
9
THD TRIM 2

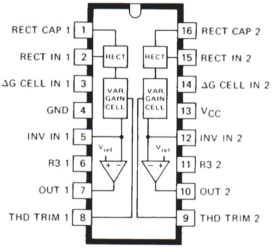
Package F, N-16

Analogue compandor

NE571

Temperature range:
Industrial –40 °C to 70 °C NE571F, N

- Complete IC compressor expandor
- 110 dB dynamic range
- Operates down to 6 V
- Typical noise 10 μV
- Full audio bandwidth


RECT CAP 1
1
RECT IN 1
2
ΔG CELL IN 1
3
GND
4
INV IN 1
5
R3 1
6
OUT 1
7
THD TRIM 1
8
RECT
VAR GAIN CELL
Vref
+ −
− +
16
RECT CAP 2
15
RECT IN 2
14
ΔG CELL IN 2
13
VCC
12
INV IN 2
11
R3 2
10
OUT 2
9
THD TRIM 2

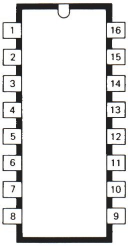
Package F, N-16

Phase locked loop

NE575

Temperature range:
Commercial 0 °C to 70 °C NE575N

- Single crystal
- Binary input
- ROM-programmed
- Supply 8 to 16 V


1
2
3
4
5
6
7
8
16
15
14
13
12
11
10
9

Package N-16

telecommunications

abridged data

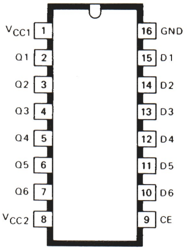
Sextuple latch

NE593

Temperature range:

Industrial	–25 °C to 85 °C	NE593N

- Driving loads from 30 V supply
- 100 mA output
- TTL inputs
- Chip enable


V_{CC1}
1
Q1
2
Q2
3
Q3
4
Q4
5
Q5
6
Q6
7
V_{CC2}
8
16
GND
15
D1
14
D2
13
D3
12
D4
11
D5
10
D6
9
CE

Package N-16

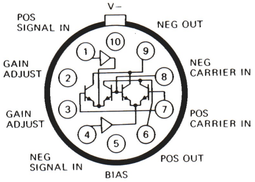
Double balanced mixer/modulator

NE/SE5596

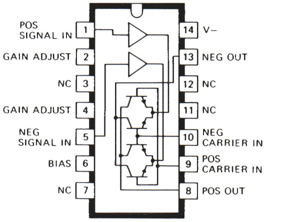
Temperature range:

Military	–55 °C to 125 °C	SE5596F, K, N
Commercial	0 °C to 70 °C	NE5596F, K, N

- Carrier suppression 65 dB typical at 0,5 MHz
- Common mode rejection 85 dB


V–
POS
SIGNAL IN
NEG OUT
GAIN
ADJUST
NEG
CARRIER IN
GAIN
ADJUST
POS
CARRIER IN
NEG
SIGNAL IN
POS OUT
BIAS
1
2
3
4
5
6
7
8
9
10

Package K


POS
SIGNAL IN
1
GAIN ADJUST
2
NC
3
GAIN ADJUST
4
NEG
SIGNAL IN
5
BIAS
6
NC
7
14
V–
13
NEG OUT
12
NC
11
NC
10
NEG
CARRIER IN
9
POS
CARRIER IN
8
POS OUT

Package F, N-14

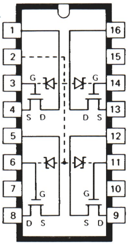
Quad analogue S.P.S.T. switch

SD5000

Temperature range:

Commercial	0 °C to 85 °C	SD5000F, N

- Analogue signal range ± 10 V
- Ultra-fast t_d(ON) 1 ns(max)
- Isolation (at 3 kHz) 105 dB (typ)
- ON resistance 30 Ω (typ)
- Low feed-through and feedback transients
- Zener diode protected

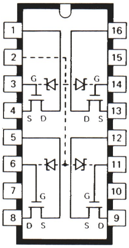

1
2
3
4
5
6
7
8
16
15
14
13
12
11
10
9
G
S
D
G
D
S
G
D
S
G
S
D

Package F, N-16

Quad analogue S.P.S.T. switch SD5001

Temperature range:
Commercial 0 °C to 85 °C SD5001F, N

- Analogue signal range ± 5 V
- Ultra-fast t_d(ON) 1 ns (max)
- Isolation (at 3 kHz) – 105 dB (typ)
- ON resistance 30 Ω (typ)
- Low feed-through and feedback transients
- Zener diode protected

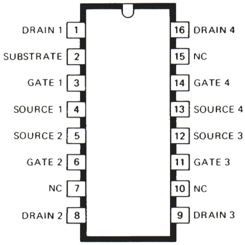

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
G
G
S D
D S
G
G
D S
S D

Package F, N-16

30 V driver circuit SD5002

Temperature range:
Commercial 0 °C to 85 °C SD5002F, N

- Analogue signal range ± 7,5 V
- Ultra-fast t_d(ON) 1 ns (max)
- Isolation (at 3 kHz) – 105 dB (typ)
- ON resistance 30 Ω (typ)
- Low feed-through and feedback transients
- Zener diode protected

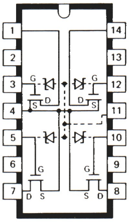

DRAIN 1 1
SUBSTRATE 2
GATE 1 3
SOURCE 1 4
SOURCE 2 5
GATE 2 6
NC 7
DRAIN 2 8
16 DRAIN 4
15 NC
14 GATE 4
13 SOURCE 4
12 SOURCE 3
11 GATE 3
10 NC
9 DRAIN 3

Package F, N-16

Four channel multiplexer SD5100

Temperature range:
Commercial 0 °C to 85 °C SD5100F, N

- Analogue signal range ± 10 V
- Ultra-fast t_d(ON) 1 ns(max)
- Isolation (at 3 kHz) – 105 dB (typ)
- ON resistance 30 Ω (typ)
- Low feed-through and feedback transients
- Zener diode protected

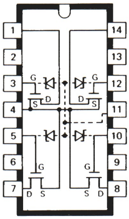

1
2
3
4
5
6
7
8
9
10
11
12
13
14
G
G
S D
D S
G
G
D S
S D

Package F, N-14

Four channel multiplexer SD5101

Temperature range:
Commercial 0 °C to 85 °C SD5101F, N

- Analogue signal range ± 5 V
- Ultra-fast t_d(ON) 1 ns(max)
- Isolation (at 3 kHz) –105 dB (typ)
- ON resistance 30 Ω (typ)
- Low feed-through and feedback transients
- Zener diode protected


1
2
3
4
5
6
7
8
9
10
11
12
13
14
G
G
S D
D S
G
G
D S
S D

Package F, N-14

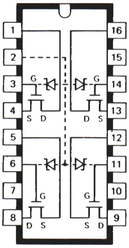
telecommunications

abridged data

Quad analogue S.P.S.T. driver SD5200

Temperature range:
Commercial 0 °C to 85 °C SD5200F, N

- Drive capability ± 15 V
- Ultra-fast t_d(ON) 1 ns(max)
- Isolation (at 3 kHz) – 105 dB (typ)
- ON resistance 30 Ω (typ)
- Low feed-through and feedback transients
- Zener diode protected


1
2
3
4
5
6
7
8
16
15
14
13
12
11
10
9
G
S D
D S
G
D S
S D

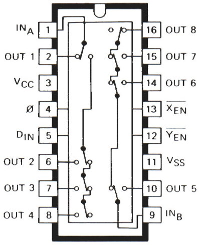
Package F, N-16

Cross point switch SD5301

Temperature range:
Commercial 0 °C to 70 °C SD5301F, N

Insertion loss	0,1 dB (typ)
Crosstalk	–120 dB (typ)
Isolation	–120 dB (typ)
Supply current	4 mA (typ)
V_{DD}	10-15 V

- TTL/C-MOS compatible controls

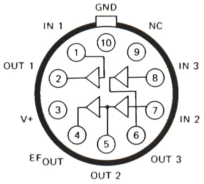

IN A
OUT 1
VCC
Ø
DIN
OUT 2
OUT 3
OUT 4
1
2
3
4
5
6
7
8
16
15
14
13
12
11
10
9
OUT 8
OUT 7
OUT 6
XEN
YEN
VSS
OUT 5
INB

Package F, N-16

Triple amp TAA960

Temperature range:
Ext. Ind. –55 °C to 65 °C TAA960

- Input resistance 25 kΩ (min)
- Supply current 2 mA (typ)
- Voltage gain 39 dB (typ)
- Emitter follower output stage

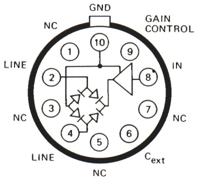

GND
IN 1
NC
OUT 1
IN 3
V+
IN 2
EFOUT
OUT 3
OUT 2
1
2
3
4
5
6
7
8
9
10

Package K

Microphone amp TAA970

Temperature range:
Industrial –35 °C to 75 °C TAA970

- Reversible polarity
- Line current 10 to 100 mA
- Voltage drop 4,8 V (typ)

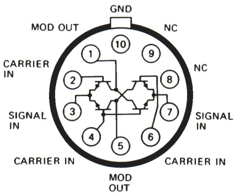

GND
NC
GAIN CONTROL
LINE
IN
NC
NC
LINE
Cext
NC
1
2
3
4
5
6
7
8
9
10

Package K

Ring modulator TBA673

Temperature range:
Industrial –25 °C to 75 °C TBA673

- Closely matched transistors
- I_{CBO} less than 100 nA
- f_T 160 MHz (typ)

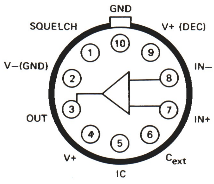

GND
MOD OUT
NC
CARRIER IN
NC
SIGNAL IN
SIGNAL IN
CARRIER IN
CARRIER IN
MOD OUT
1
2
3
4
5
6
7
8
9
10

Package K

Low power audio amp TBA915

Temperature range:
Military –55 °C to 125 °C TBA915

- Quiescent current 2 mA (typ)
- Output power 500 mW
- Total harmonic distortion less than 5%
- Supply voltage 12 V

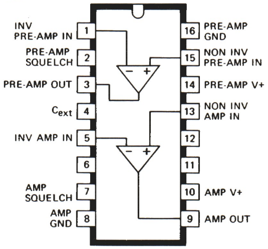

GND
SQUELCH
V+ (DEC)
V–(GND)
IN–
OUT
IN+
V+
C_{ext}
IC
1
2
3
4
5
6
7
8
9
10

Package K

Low power audio amp TCA210

Temperature range:
Military –55 °C to 125 °C TCA210

- Separate pre-amp
- Power output 500 mW
- Total harmonic distortion less than 5%
- Quiescent current 8 mA (typ)
- Pre-amp voltage gain 10 000
  noise figure typ. 4 dB
- Supply 12 V

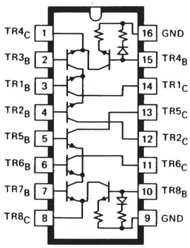

INV PRE-AMP IN 1
PRE-AMP SQUELCH 2
PRE-AMP OUT 3
C_{ext} 4
INV AMP IN 5
6
AMP SQUELCH 7
AMP GND 8
16 PRE-AMP GND
15 NON INV PRE-AMP IN
14 PRE-AMP V+
13 NON INV AMP IN
12
11
10 AMP V+
9 AMP OUT
–
+
–
+

Package N-16

Double balanced mixer/modulator TCA240

Temperature range:
Industrial –20 °C to 70 °C TCA240

- V_{BE} match less than 2,5 mV
- h_{FE} 23 to 190


$TR4_C$ 1
$TR3_B$ 2
$TR1_B$ 3
$TR2_B$ 4
$TR5_B$ 5
$TR6_B$ 6
$TR7_B$ 7
$TR8_C$ 8
16 GND
15 $TR4_B$
14 $TR1_C$
13 $TR5_C$
12 $TR2_C$
11 $TR6_C$
10 $TR8_B$
9 GND

Package N-16

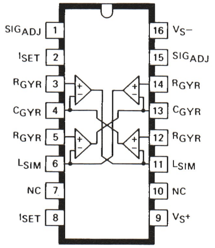
telecommunications

abridged data

Gyrator TCA580

Temperature range:
Industrial −20 °C to 70 °C TCA580

- Frequency range DC to 10 kHz
- Q factor over 500
- Very high simulated inductance

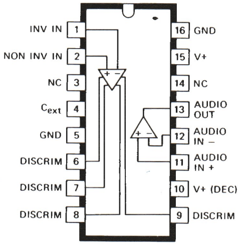

SIG_{ADJ} 1
I_{SET} 2
R_{GYR} 3
C_{GYR} 4
R_{GYR} 5
L_{SIM} 6
NC 7
I_{SET} 8
16 V_{S-}
15 SIG_{ADJ}
14 R_{GYR}
13 C_{GYR}
12 R_{GYR}
11 L_{SIM}
10 NC
9 V_{S+}

Package N-16

IF limiter amp TCA770A

Temperature range:
Industrial −30 °C to 70 °C TCA770A

- Total current consumption 450 µA
- Supply voltage 7,5 V
- Frequency range 100-500 kHz
- AM rejection 50 dB (typ)

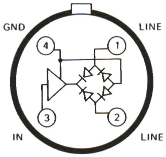

INV IN 1
NON INV IN 2
NC 3
C_{ext} 4
GND 5
DISCRIM 6
DISCRIM 7
DISCRIM 8
16 GND
15 V+
14 NC
13 AUDIO OUT
12 AUDIO IN −
11 AUDIO IN +
10 V+ (DEC)
9 DISCRIM

Package N-16

Microphone amp TCA980

Temperature range:
Military −55 °C to 125 °C TDA980

- Reversible polarity
- Line current 10 to 100 nA
- Voltage drop 4,5 V (typ)

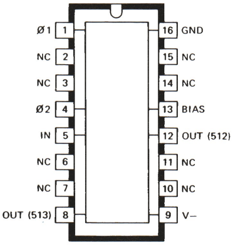

GND
LINE
4
1
3
2
IN
LINE

Package DE

Bucket brigade delay line TDA1022 NE502

Temperature range:
Industrial −20 °C to 85 °C TDA1022 ,NE502N

- Clock frequency 5 to 500 kHz
- 512 buckets
- Signal delay 0,5 to 50 ms
- Frequency range 0 to 45 kHz
- Attenuation 4 dB (typ)


Ø1 1
NC 2
NC 3
Ø2 4
IN 5
NC 6
NC 7
OUT (513) 8
16 GND
15 NC
14 NC
13 BIAS
12 OUT (512)
11 NC
10 NC
9 V−

Package N-16

LOCMOS

HE4000B family

For detailed information
Handbook SC6

The LOCMOS HE4000B range is a fully buffered digital integrated circuit family which meets the Jedec-B specification. The members of this family are plug-in replacements for the well-known C-MOS 4000 and 14500 ranges. The HE family has the same advantages as conventional C-MOS circuits, plus the additional LOCMOS advantages. Recommended supply voltage range 3 to 15 V.

LOCMOS means Local Oxidation Complementary MOS.

Inputs and outputs are protected against electrostatic effects in a wide variety of device-handling situations. However, to be totally safe, it is desirable to take handling precautions into account.

Advantages of the C-MOS:

- low power dissipation — typically 10 nW per gate (static)
- wide operating supply voltage range
- wide operating temperature range from —40 to +85 °C
- high d.c. fan-out
- inputs and outputs are protected against electrostatic voltages

In addition to these, the LOCMOS HE4000B range has:

- buffered outputs on **all** circuits
- higher speed
- higher packing density — essential for MSI/LSI
- excellent noise immunity

The HE family is designed with standardized output drive characteristics which, combined with relative intensitivity to output capacitance loading, simplify system design.

Family ratings

Limiting values in accordance with the Absolute Maximum System (IEC 134)

supply voltage	V_{DD}		—0,5 to +18	V
voltage on any input	V_I		—0,5 to (V_{DD} + 0,5)	V *
current into any input	$\pm I_I$	max.	10	mA
power dissipation per package				
for T_{amb} = —40 to +60 °C	P_{tot}	max.	400	mW
for T_{amb} = + 60 to +85 °C	derate linearly with 8 mW/°C to 200 mW			
operating ambient temperature	T_{amb}		—40 to +85	°C
storage temperature	T_{stg}		—65 to +150	°C

* V_{DD} + 0,5 V should not exceed 18 V.

Type numbers have a suffix which signifies the type of package: P = plastic DIL; D = ceramic DIL

Family characteristics (d.c.) at V_{SS} = 0

parameter	symbol	T_{amb} = −40 °C		T_{amb} = +25 °C		T_{amb} = +85 °C		V_{DD}	conditions
		min	max	min	max	min	max	V	
Quiescent device current for gates	I_{DD}(μA)	–	1,0	–	1,0	–	7,5	5	all valid input combinations; $V_I = V_{SS}$ or V_{DD}
		–	2,0	–	2,0	–	15,0	10	
		–	4,0	–	4,0	–	30,0	15	
Quiescent device current for buffers, and flip-flops	I_{DD}(μA)	–	4,0	–	4,0	–	30	5	
		–	8,0	–	8,0	–	60	10	
		–	16,0	–	16,0	–	120	15	
Quiescent device current for MSI	I_{DD}(μA)	–	20	–	20	–	150	5	
		–	40	–	40	–	300	10	
		–	80	–	80	–	600	15	
Quiescent device current for LSI	I_{DD}(μA)	–	50	–	50	–	375	5	
		–	100	–	100	–	750	10	
		–	200	–	200	–	1500	15	
Output voltage LOW $\lvert I_O \rvert < 1\ \mu$A	V_{OL}(V)	–	0,05	–	0,05	–	0,05	5	$V_I = V_{SS}$ or V_{DD}
		–	0,05	–	0,05	–	0,05	10	
		–	0,05	–	0,05	–	0,05	15	
Output voltage HIGH $\lvert I_O \rvert < 1\ \mu$A	V_{OH}(V)	4,95	–	4,95	–	4,95	–	5	$V_I = V_{SS}$ or V_{DD}
		9,95	–	9,95	–	9,95	–	10	
		14,95	–	14,95	–	14,95	–	15	
Input voltage LOW $\lvert I_O \rvert < 1\ \mu$A	V_{IL}(V)	–	1,5	–	1,5	–	1,5	5	V_O = 0,5 or 4,5 V
		–	3,0	–	3,0	–	3,0	10	V_O = 1,0 or 9,0 V
		–	4,0	–	4,0	–	4,0	15	V_O = 1,5 or 13,5 V
Input voltage HIGH $\lvert I_O \rvert < 1\ \mu$A	V_{IH}(V)	3,5	–	3,5	–	3,5	–	5	V_O = 0,5 or 4,5 V
		7,0	–	7,0	–	7,0	–	10	V_O = 1,0 or 9,0 V
		11,0	–	11,0	–	11,0	–	15	V_O = 1,5 or 13,5 V
Output (sink) current LOW	I_{OL}(mA)	0,52	–	0,44	–	0,36	–	5	V_O = 0,4; V_I = 0 or 5 V
		1,3	–	1,1	–	0,9	–	10	V_O = 0,5; V_I = 0 or 10 V
		3,6	–	3,0	–	2,4	–	15	V_O = 1,5; V_I = 0 or 15 V
Output (source) current HIGH	$-I_{OH}$(mA)	0,52	–	0,44	–	0,36	–	5	V_O = 4,6; V_I = 0 or 5 V
		1,3	–	1,1	–	0,9	–	10	V_O = 9,5; V_I = 0 or 10 V
		3,6	–	3,0	–	2,4	–	15	V_O = 13,5; V_I = 0 or 15 V
Input leakage current	$\pm I_{IN}$(μA)	–	0,3	–	0,3	–	1,0	15	V_I = 0 or 15 V
Three-state output leakage current; HIGH	I_{OZH}(μA)	–	1,6	–	1,6	–	12,0	15	output returned to V_{DD}
Three-state output leakage current; LOW	$-I_{OZL}$(μA)	–	1,6	–	1,6	–	12,0	15	output returned to V_{DD}
Input capacitance per unit load	C_{IN}(pF)	–	–	–	7,5	–	–	–	any input

***CP= clock input to output**
I = input to output
one figure means equal delays

conditions for t_{PLH}; t_{PHL}; f_{max}; dissipation: V_{DD} = 10 V; C_L = 50 pF			propagation delay * t_{PLH}; t_{PHL} ns	maximum clock pulse frequency MHz	dynamic dissipation at 1 MHz mW
NAND gates	**HEF4011B**	quadruple 2-input NAND gate	(I) 25	–	26
	HEF4012B	dual 4-input NAND gate	(I) 30; 25	–	14
	HEF4023B	triple 3-input NAND gate	(I) 30; 25	–	20
	HEF4068B	8-input NAND gate	(I) 35; 40	–	8
AND gates	**HEF4073B**	triple 3-input AND gate	(I) 20; 25	–	18
	HEF4081B	quadruple 2-input AND gate	(I) 20; 25	–	24
	HEF4082B	dual 4-input AND gate	(I) 30	–	17
NOR gates	**HEF4000B**	dual 3-input NOR gate and inverter	(I) 35	–	23
	HEF4001B	quadruple 2-input NOR gate	(I) 25	–	25
	HEF4002B	dual 4-input NOR gate	(I) 25	–	14
	HEF4025B	triple 3-input NOR gate	(I) 25	–	19
	HEF4078B	8-input NOR gate	(I) 35	–	8
OR gates	**HEF4071B**	quadruple 2-input OR gate	(I) 20; 25	–	25
	HEF4072B	dual 4-input OR gate	(I) 35	–	15
	HEF4075B	triple 3-input OR gate	(I) 30	–	19
Inverters and buffers	**HEF4007UB**	dual complementary pair and inverter	(I) 20	–	35
	HEF4041B	quadruple true/complement buffer	(I) 20	–	53
	HEF4049B	hex inverting buffers	(I) 30; 20	–	46
	HEF4050B	hex non-inverting buffers	(I) 25; 20	–	42
	HEF4069UB	hex inverter	(I) 20	–	34
	HEF4502B	strobed hex inverter/buffer	(I) 45	–	55
	HEF40097B	3-state hex non-inverting buffer	(I) 25; 30	–	55
	HEF40098B	3-state hex inverting buffer	(I) 30; 35	–	53
Complex gates	**HEF4030B**	quadruple EXCLUSIVE-OR gate	(I) 30; 35	–	25
	HEF4070B	quadruple EXCLUSIVE-OR gate	(I) 30; 35	–	25
	HEF4077B	quadruple EXCLUSIVE-NOR gate	(I) 30; 35	–	25
	HEF4085B	dual 2-wide 2-input AND-OR-invert gate	(I) 30	–	13
	HEF4086B	4-wide 2-input AND-OR-invert gate	(I) 40	–	8
Flip-flops	**HEF4013B**	dual D-type flip-flop	(CP) 40	25	15
	HEF4027B	dual JK flip-flop	(CP) 50	15	14
	HEF4076B	quadruple D-type flip-flop with 3-state outputs	(CP) 65; 60	22	19
	HEF40174B	hex D-type flip-flop	(CP) 30	30	31
	HEF40175B	quadruple D-type flip-flop	(CP) 30; 35	30	28
Specials	**HEF4046B**	phase-locked loop			
	HEF4738V	IEC/IEEE bus interface			
	HEF4739V	digital voltmeter circuit			

LOCMOS

HE4000B family

*CP= clock input to output
I = input to output
one figure means equal delays

conditions for t_{PLH}; t_{PHL}; f_{max}; dissipation: V_{DD} = 10 V; C_L = 50 pF			propagation delay *	t_{PLH}; t_{PHL} ns	maximum clock pulse frequency MHz	dynamic dissipation at 1 MHz mW
Counters	**HEF4017B**	5-stage Johnson counter	(CP)	95; 75	16	7
	HEF4018B	presettable divide-by-n counter	(CP)	55; 65	11	8
	HEF4020B	14-stage binary counter	(CP)	50; 45	25	8
	HEF4022B	4-stage divide-by-8 Johnson counter	(CP)	95; 75	16	7
	HEF4024B	7-stage binary counter	(CP)	45:40	25	8
	HEF4029B	synchronous up/down counter, binary/decade counter	(CP)	60; 55	25	10
	HEF4040B	12-stage binary counter	(CP)	50; 45	25	9
	HEF4510B	BCD up/down counter	(CP)	65; 60	24	10
	HEF4516B	binary up/down counter	(CP)	65; 60	24	10
	HEF4518B	dual BCD up counter	(CP)	65; 75	15	13
	HEF4520B	dual binary counter	(CP)	65; 75	15	13
	HEF4521B	24-stage frequency divider	(I)	400	25	10
	HEF4522B	programmable 4-bit BCD down counter		–	–	–
	HEF4526B	programmable 4-bit binary down counter		–	–	–
	HEF4534B	real time 5-decade counter	(CP)	750	6	–
	HEF4737B; V	quadruple static decade counters	(CP)	450	10	–
	HEF40160B	4-bit synchronous decade counter with asynchronous reset	(CP)	45	25	11
	HEF40161B	4-bit synchronous binary counter with asynchronous reset	(CP)	45	25	11
	HEF40162B	4-bit synchronous decade counter with synchronous reset	(CP)	45	25	11
	HEF40163B	4-bit synchronous binary counter with synchronous reset	(CP)	45	25	11
	HEF40192B	4-bit up/down decade counter	(CP)	70; 85	18	7
	HEF40193B	4-bit up/down binary counter	(CP)	70; 85	18	8
Registers	**HEF4006B**	18-stage static shift register	(CP)	40	30	18
	HEF4014B	8-bit shift register	(CP)	50; 60	22	13
	HEF4015B	dual 4-bit static shift register	(CP)	55; 60	23	28
	HEF4021B	8-bit static shift register	(CP)	55; 65	25	13
	HEF4031B	64-stage static shift register	(CP)	80; 85	14	19
	HEF4035B	4-bit universal shift register	(CP)	65; 70	25	15
	HEF4076B	quadruple D-type register with 3-state outputs	(CP)	65; 60	22	19
	HEF4094B	8-stage shift-and-store bus register	(CP)	120	8	–
	HEF4517B	dual 64-bit static shift register	(CP)	80; 85	14	45
	HEF4557B	1-to-64-bit variable length shift register	(CP)	80; 85	14	17
	HEF4731B; V	quadruple 64-bit static shift registers	(CP)	80; 85	14	60
	HEF40194B	4-bit bidirectional universal shift register	(CP)	35; 40	30	17
	HEF40195B	4-bit universal shift register	(CP)	45; 50	28	21
Digital multiplexers	**HEF4019B**	quadruple 2-input multiplexer	(I)	25; 30	–	25
	HEF4512B	8-input multiplexer with 3-state output	(I)	40; 35	–	7
	HEF4519B	quadruple 2-input multiplexer	(I)	40; 45	–	26
	HEF4539B	dual 4-input multiplexer	(I)	50; 45	–	13

***A = address to output**
D = data to output
I = input to output
R/S = reset/set input to output
t_{ACC} = read access time
ST = strobe input to output
one figure means equal delays

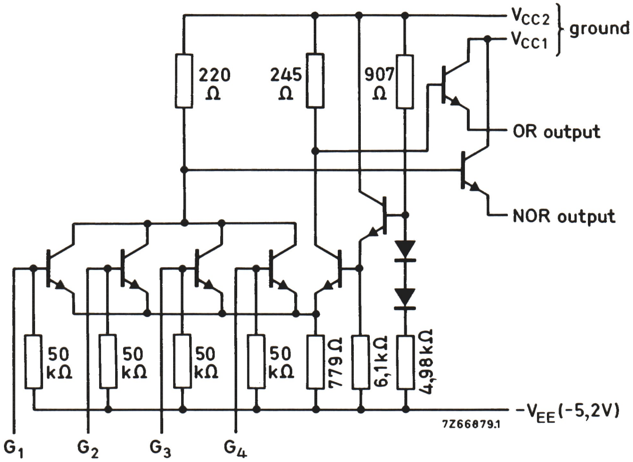
conditions for t_{PLH}; t_{PHL}; f_{max}; dissipation: V_{DD} = 10 V; C_L = 50 pF			propagation delay * t_{PLH}; t_{PHL}		ON-state frequency response	dynamic dissipation at 1 MHz
				ns	MHz	mW
Decoders	**HEF4028B**	1-of-10 decoder	(A)	45; 50	–	13
	HEF4511B	BCD to 7-segment latch/decoder/driver	(A)	55; 60	–	44
	HEF4514B	1-of-16 decoder/demultiplexer with input latches	(A)	95	–	11
	HEF4515B	1-of-16 decoder/demultiplexer with input latches	(A)	95	–	11
	HEF4543B	BCD to 7-segment latch/decoder driver for liquid crystal and LED displays	(A)	60; 70	–	46
	HEF4555B	dual 1-of-4 decoder/demultiplexer	(A)	55; 45	–	29
	HEF4556B	dual 1-of-4 decoder/demultiplexer	(A)	40; 50	–	28
Analogue switches and multiplexers/ demultiplexers	**HEF4016B**	quadruple bilateral switches	(I)	10	90	21
	HEF4051B	8-channel analogue multiplexer/demultiplexer	(I)	5	40	11
	HEF4052B	dual 4-channel analogue multiplexer/demultiplexer	(I)	5	40	16
	HEF4053B	triple 2-channel analogue multiplexer/demultiplexer	(I)	5	40	27
	HEF4066B	quadruple bilateral switches	(I)	5	90	24
	HEF4067B	16-channel analogue multiplexer/demultiplexer	(I)	10; 15	40	10
Latches	**HEF4042B**	quadruple D-latch	(D)	40	–	36
	HEF4043B	quadruple R/S latch with 3-state outputs	(R/S)	25; 35	–	14
	HEF4044B	quadruple R/S latch with 3-state outputs	(R/S)	40	–	15
	HEF4508B	dual 4-bit latch	(ST)	50	–	19
	HEF4724B	8-bit addressable latch	(D)	35	–	24
Translator	**HEF4104B**	quadruple low to high voltage translator with 3-state outputs	(I)	80	–	52
Memories	**HEF4505B**	64-bit, 1-bit per word read/write RAM	(t_{ACC})	100	–	–
	HEF4720B; V	256-bit, 1-bit per word RAM	(t_{ACC})	130	–	–
Multivibrators	**HEF4047B**	monostable/astable multivibrator	(I)	60	–	–
	HEF4528B	dual retriggerable-resettable monostable multivibrator	(I)	60; 50	–	30
Arithmetic circuits	**HEF4008B**	4-bit binary full adder	(D)	50; 55	–	35
	HEF4531B	13-input parity checker/generator	(I)	80	–	–
	HEF4532B	8-input priority encoder	(I)	70	–	–
	HEF4585B	4-bit magnitude comparator	(I)	55; 60	–	12
Schmitt triggers	**HEF4093B**	quadruple 2-input NAND Schmitt trigger	(I)	40	–	26
	HEF4583B	dual Schmitt trigger		–	–	–
	HEF40106B	hex Schmitt trigger	(I)	40	–	40

ECL

ECL 10 000 (GX family)

The GX family of ECL silicon monolithic integrated circuits is designed for high speed central processors and digital communication systems.
With 2,0 ns typical propagation delay and only 25 mW power dissipation per gate, this family offers an excellent speed-power product and so is recommended for high speed large system design.

Basic gate circuit


V_{CC2}
V_{CC1}
ground
220 Ω
245 Ω
907 Ω
OR output
NOR output
50 kΩ
50 kΩ
50 kΩ
50 kΩ
779 Ω
6,1 kΩ
4,98 kΩ
7Z66879.1
$-V_{EE}$(−5,2V)
G_1
G_2
G_3
G_4

GX family ratings

Limiting values in accordance with the Absolute Maximum System (IEC 134)

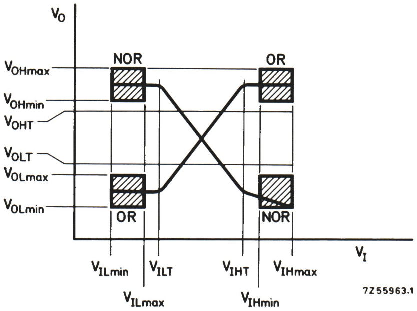
supply voltage (d.c.)	V_{EE}	max	−8,0	V
input voltage	V_I	0 to V_{EE}		
output current	I_O	max	50	mA
storage temperature	T_{stg}	−55 to +125		°C
junction temperature	T_j	max	125	°C

GX family characteristics (d.c.) at V_{CC} = ground; V_{EE} = −5,2 V

Each GX circuit has been designed to meet the d.c. specifications shown in the test table below, after thermal equilibrium has been established. The circuit is in a test socket or mounted on a printed-circuit board and transverse air flow > 2,5 m/s is maintained. Outputs are terminated via a 50 Ω resistor to −2,0 V. Test values for applied conditions are given in the table and defined in the figure.

Test table

T_{amb}	0 °C	25 °C	75 °C	
V_{IHmax}	−0,840	−0,810	−0,720	V
V_{IHT}	−1,145	−1,105	−1,045	V
V_{ILT}	−1,490	−1,475	−1,450	V
V_{ILmin}	−1,870	−1,850	−1,830	V



	symbol		T_{amb} 0 °C	 25 °C	 75 °C		conditions
output voltage HIGH	V_{OH}	min	−1000	−960	−900	mV	inputs at V_{IHmax}
		typ		−880		mV	
		max	−840	−810	−720	mV	
output voltage LOW	V_{OL}	min	−1,870	−1,850	−1,830	V	inputs at V_{ILmin}
		typ		−1,720		V	
		max	−1,665	−1,650	−1,625	V	
output threshold voltage HIGH	V_{OHT}	min	−1020	−980	−920	mV	inputs at V_{IHT}
output threshold voltage LOW	V_{OLT}	max	−1,645	−1,630	−1,605	V	inputs at V_{ILT}
input current HIGH	I_{IH}	max		265		μA	V_{IHmax} for input under test
input current LOW	I_{IL}	min		10		μA	V_{ILmin} for input under test

ECL

ECL 10 000 (GX family)

Gates	**GXB10100**	quadruple 3-input NOR gate (1 input common)
	GXB10101	quadruple 2-input OR/NOR gate (1 input common)
	GXB10102	quadruple 2-input, 3 NOR and 1 OR/NOR gate
	GXB10103	quadruple 2-input, 3 OR and 1 OR/NOR gate
	GXB10104	quadruple 2-input, 3 AND and 1 AND/NAND gate
	GXB10105	triple 2-3-2 input OR/NOR gate
	GXB10106	triple 4-3-3 input NOR gate
	GXB10107	triple 2-input EXCLUSIVE-OR/EXCLUSIVE-NOR gate
	GXB10108	dual 3-input AND/NAND gate
	GXB10109	dual 4-5 input OR/NOR gate
	GXB10110	dual 3-input/3-output OR gate (line driver)
	GXB10111	dual 3-input/3-output NOR gate (line driver)
	GXB10113	quadruple EXCLUSIVE-OR gate (with enable)
	GXB10117	dual 2-wide 2-3 input OR-AND/OR-AND-invert gate
	GXB10118	dual 2-wide 3-input OR-AND gate
	GXB10119	4-wide 4-3-3-3 input OR-AND gate
	GXB10121	4-wide OR-AND/OR-AND-invert gate
	GXB10210	high speed dual 3-input/3-output OR gate
	GXB10211	high speed dual 3-input/3-output NOR gate
Interfaces	**GXB10112**	dual 3-input/3-output (1 OR and 2 NOR) line driver
	GXB10114	triple line receiver
	GXB10115	quadruple line receiver
	GXB10116	triple line receiver
	GXB10124	quadruple TTL to ECL translator
	GXB10125	quadruple ECL to TTL translator
	GXB10129	quadruple TTL/IBM bus receiver/latch
	GXB10188	hex buffer (non-inverting)
	GXB10189	hex inverter
	GXB10212	high speed dual 3-input/3-output (1 OR and 2 NOR) line driver
	GXB10216	high speed triple line receiver
Flip-flops	**GXB10130**	dual D-type latch
	GXB10131	dual D-type master-slave flip-flop
	GXB10133	quadruple latch with D-type inputs and enable outputs
	GXB10135	dual JK master-slave flip-flop
	GXB10175	quint D-latch with common reset and two wired-OR common clock inputs
	GXB10176	hex D-type master-slave flip-flop
	GXB10231	high speed dual D-type master-slave flip-flop
Counters and registers	**GXB10136**	universal hexadecimal counter
	GXB10137	universal decade counter
	GXB10141	4-bit universal shift register

Type numbers have a suffix which signifies the type of package: P = plastic DIL; D = ceramic DIL; E = metal-ceramic (for memories only)

Complex	**GXB10132**	dual 2-input multiplexer with clocked D-type latches and common reset
	GXB10134	dual 2-input multiplexer with clocked D-type latches
	GXB10158	quadruple 2-to-1 multiplexer (non-inverting)
	GXB10159	quadruple 2-to-1 multiplexer (inverting)
	GXB10160	12-bit parity checker/generator
	GXB10161	3-bit decoder with two enable inputs (1 of 8 lines LOW)
	GXB10162	3-bit decoder with two enable inputs (1 of 8 lines HIGH)
	GXB10164	8-input multiplexer with enable input
	GXB10165	8-input priority encoder
	GXB10170	9-bit parity checker/generator
	GXB10171	dual 2-bit decoder (one of four lines LOW)
	GXB10172	dual 2-bit decoder (one of four lines HIGH)
	GXB10173	quadruple 2-input multiplexer with latched outputs
	GXB10174	dual 4-to-1 multiplexer (with enable)
	GXB10179	look-ahead carry block
	GXB10180	dual 2-bit adder/subtractor
	GXB10181	4-bit arithmetic logic unit
	GXB10190	quadruple differential receiver/MST-ECL translator
	GXB10191	hex ECL-MST translator
Memories	**GXB10139**	256-bit, 8-bits per word PROM
	GXB10140	64-bit, 1-bit per word RAM (90 Ω output)
	GXB10142	fast 64-bit, 1-bit per word RAM
	GXB10144	256-bit, 1-bit per word RAM
	GXB10145	64-bit, 4-bits per word RAM
	GXB10146	1024-bit, 1-bit per word RAM
	GXB10148	64-bit, 1-bit per word RAM (50 Ω output)
	GXB10149	1024-bit, 4-bits per word PROM
	GXB10155	16-bit, 2-bits per word CAM (content addressable memory)
	GXB10405	128-bit, 1-bit per word RAM
	GXB10410	256-bit, 1-bit per word RAM
	GXB10415	1024-bit, 1-bit per word RAM

ECL

u.h.f. dividers

Type numbers have a suffix which signifies the type of package: P = plastic DIL, E = metal-ceramic

Temperature range: –40 to 85 °C

SAF1034E	4-to-1 divider 1,05 GHz
SAF1534E	4-to-1 divider 1,5 GHz

Temperature range: 0 to 75 °C

SAB1034P	4-to-1 divider 1,05 GHz
SAB1534P	4-to-1 divider 1,5 GHz

- dividers by four
- supply voltage: –5,2 V ± 5%
- power consumption: 250 mW (typ)
- output levels: ECL 10 000
- differential inputs
- packages: plastic and metal-ceramic DIL 14 pins

Applications

- high speed instrumentation (counters and frequency meters, synthesizers, oscilloscopes, nuclear instrumentation)
- telecommunications

TTL

survey

Military types	**Commercial types**		page
S54 . . series	**N74 . . series**	standard-range gold doped TTL	B110-B112
S54H . . series	**N74H . . series**	high-speed gold doped TTL	B113
S54S . . series	**N74S . . series**	high-speed Schottky TTL	B114-B115
S54LS . . series	**N74LS . . series**	low-power Schottky TTL	B116-B118
S82 . . series	**N82 . . series**	proprietary Schottky TTL	B119-B120
	N82S . . series	proprietary Schottky TTL	B121
S8T . . series	**N8T . . series**	TTL interface	B122

For military products see also pages B231-B237

Ratings

		Commercial types **N74, N74H, N74S, N74LS**	**Commercial types** **N82, N82S**	**Military types**	
supply voltage V_{CC}	min	4,75	4,75	4,5	V
	nom	5,0	5,0	5,0	V
	max	5,25	5,25	5,5	V
ambient temperature	min	0	0	−55	°C
	max	70	75	125	°C
storage temperature	min	−65	−65	−65	°C
	max	150	175	150	°C
				S82 and S8T max 200	°C

Characteristics

	S54/N74	**S54H/N74H**	**S54S/N74S**	**S54LS/N74LS**	**S82/N82**	**N82S**	
typ power dissipation per gate	10	23	20	2	10	20	mW
typ gate propagation delay	10	6	3	10	10	3	ns

Packages

Military types are generally available in both hermetic dual in-line (CERDIP) and hermetic flat package (CERPAC). Commercial types are predominantly supplied in plastic dual in-line package.

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S54/N74 . .series

Gates	**S54/N7400**	quadruple 2-input positive NAND gate
	S54/N7401	quadruple 2-input positive NAND gate with open collector output
	S54/N7402	quadruple 2-input positive NOR gate
	S54/N7403	quadruple 2-input positive NAND gate with open collector output
	S54/N7408	quadruple 2-input positive AND gate
	S54/N7409	quadruple 2-input AND gate with open collector output
	S54/N7410	triple 3-input positive NAND gate
	S54/N7411	triple 3-input positive AND gate
	S54/N7412	triple 3-input NAND gate with open collector output
	S54/N7420	dual 4-input positive NAND gate
	S54/N7421	dual 4-input positive AND gate
	N7425	dual 4-input positive NOR gate (with strobe)
	S54/N7426	quadruple 2-input NAND gate with open collector output
	S54/N7427	triple 3-input NOR gate
	S54/N7430	8-input positive NAND gate
	S54/N7432	quadruple 2-input positive OR gate
	S54/N7450	expandable dual 2-wide 2-input AND-OR-invert gate
	S54/N7451	dual 2-wide 2-input AND-OR-invert gate
	S54/N7453	4-wide 2-input AND-OR-invert gate (expandable)
	S54/N7454	4-wide 2-input AND-OR-invert gate
	S54/N7460	dual 4-input expander
	S54/N7486	quadruple 2-input EXCLUSIVE-OR gate
Buffers, inverters	**S54/N7404**	hex inverter
	S54/N7405	hex inverter with open collector output
	S54/N7406	hex inverter buffer/driver with open collector output
	S54/N7407	hex buffer/driver with open collector output
	S54/N7416	hex inverter buffer/driver with open collector output
	S54/N7417	hex buffer/driver with open collector output
	S54/N7428	quadruple 2-input positive NOR buffer
	S54/N7433	quadruple 2-input positive NOR buffer
	S54/N7437	quadruple 2-input positive NAND buffer
	S54/N7438	quadruple 2-input positive NAND buffer with open collector output
	S54/N7440	dual 4-input positive NAND buffer
Bus drivers transceivers	**S54/N74125**	quadruple bus buffer gate with three-state outputs
	S54/N74126	quadruple bus buffer gate with three-state outputs
	S54/N74128	quadruple 2-input positive NOR buffer
	S54/N74365A	hex three-state buffer
	S54/N74366A	hex three-state inverter
	S54/N74367A	hex three-state buffer
	S54/N74368A	hex three-state inverter

Flip-flops	**S54/N7413**	dual NAND Schmitt trigger
	S54/N7414	hex Schmitt trigger
	S54/N7470	JK flip-flop
	S54/N7472	JK master-slave flip-flop
	S54/N7473	dual JK master-slave flip-flop
	S54/N7474	dual D-type edge-triggered flip-flop
	S54/N7476	dual JK master-slave flip-flop
	S54/N74107	dual JK master-slave flip-flop
	S54/N74109	dual JK positive edge-triggered flip-flop
	S54/N74121	monostable multivibrator
	N74122	retriggerable monostable multivibrator
	S54/N74123	retriggerable monostable multivibrator
	S54/N74132	quadruple Schmitt trigger
	S54/N74173	quadruple D-type flip-flop (three-state) (8T10)
	S54/N74174	hex D-type flip-flop with clear
	S54/N74175	quadruple D-type edge-triggered flip-flop
	N74221	dual monostable multivibrator
Shift registers	**S54/N7491**	8-bit shift register
	S54/N7494	4-bit shift register parallel-in/serial-out
	S54/N7495	4-bit left-right shift register
	S54/N7495A	4-bit left-right shift register
	S54/N7496	5-bit shift register
	S54/N74164	8-bit parallel-out serial shift register
	S54/N74165	parallel-load 8-bit shift register
	S54/N74166	8-bit shift register
	S54/N74170	4 x 4 register file
	N74178	4-bit parallel access shift register
	N74179	4-bit parallel access shift register
	S54/N74194	4-bit bidirectional universal shift register
	S54/N74195	4-bit parallel-access shift register
	S54/N74198	8-bit shift register
	S54/N74199	8-bit shift register
Counters	**S54/N7490**	decade counter
	S54/N7492	divide-by-twelve counter
	S54/N7493	4-bit binary counter
	S54/N74160	synchronous 4-bit decade counter
	S54/N74161	synchronous 4-bit binary counter
	S54/N74162	synchronous 4-bit decade counter
	S54/N74163	synchronous 4-bit binary counter
	N74176	presettable decade counter/latch
	N74177	presettable binary counter/latch
	N74190	synchronous up/down counter (BCD)
	N74191	synchronous up/down counter (binary)
	S54/N74192	synchronous decade up/down counter
	S54/N74193	synchronous 4-bit binary up/down counter
	N74196	presettable decade counter/latch
	N74197	presettable binary counter/latch

TTL

S54/N74 . .series

Latches	**S54/N7475**	quadruple bistable latch
	S5477	quadruple bistable latch
	S54/N74100	4-bit bistable latch (dual)
	S54/N74116	dual 4-bit latch with clear
	S54/N74279	quadruple S-R latch
Decoders-drivers	**S54/N7445**	BCD-to-decimal decoder/driver with open collector output
	S54/N7446A	BCD-to-7 segment decoder/driver
	S54/N7447A	BCD-to-7 segment decoder/driver
	S54/N7448	BCD-to-7 segment decoder/driver
	S54/N74145	BCD-to-decimal decoder/driver with open collector output
Decoder-multiplexers	**S54/N7442**	BCD-to-decimal decoder
	S54/N7443	excess 3-to-decimal decoder
	S54/N7444	excess 3-gray-to-decimal decoder
	S54/N74147	10-line to 4-line priority encoder
	S54/N74148	8-line to 3-line priority encoder
	S54/N74150	16-line to 1-line multiplexer
	S54/N74151	8-line to 1-line multiplexer
	S54/N74152	8-line to 1-line multiplexer
	S54/N74153	dual 4-line to 1-line multiplexer
	S54/N74154	4-line to 16-line decoder/demultiplexer
	S54/N74155	dual 2-line to 4-line decoder/demultiplexer
	S54/N74156	2-line to 4-line decoder demultiplexer
	S54/N74157	quadruple 2-input data selector (non-inverting)
	S54/N74158	quadruple 2-input data selector (inverting)
	S54/N74298	quadruple 2-input multiplexer with storage
Arithmetic units	**S54/N7480**	gated full adder
	S54/N7483	4-bit binary full adder
	N7483A	4-bit binary full adder
	S54/N7485	4-bit magnitude comparator
	S54/N74180	8-bit odd/even parity checker
	S54/N74181	4-bit arithmetic logic unit
	S54/N74182	look-ahead carry generator
	N74280	9-bit odd/even parity generator/checker
	N74283	4-bit adder

S54H/N74H . .series

Gates	**S54H/N74H00**	quadruple 2-input positive NAND gate
	S54H/N74H01	quadruple 2-input positive NAND gate with open collector output
	S54H/N74H08	quadruple 2-input positive AND gate
	S54H/N74H10	triple 3-input positive NAND gate
	S54H/N74H11	triple 3-input positive AND gate
	S54H/N74H20	dual 4-input positive NAND gate
	S54H/N74H21	dual 4-input positive AND gate
	S54H/N74H22	dual 4-input positive NAND gate with open collector output
	S54H/N74H30	8-input positive NAND gate
	S54H/N74H50	expandable dual 2-wide 2-input AND-OR-invert gate
	S54H/N74H51	dual 2-wide 2-input AND-OR-invert gate
	S54H/N74H52	expandable 4-wide 2-2-2-3 input AND-OR
	S54H/N74H53	4-wide 2-input AND-OR-invert gate (expandable)
	S54H/N74H54	4-wide 2-input AND-OR-invert gate
	S54H/N74H55	2-wide 2-input AND-OR-invert gate
	S54H/N74H60	dual 4-input expander
	S54H/N74H61	triple 3-input expander
	S54H/N74H62	3-2-2-3-input AND-OR expander
Buffers, inverters	**S54H/N74H04**	hex inverter
	S54H/N74H05	hex inverter with open collector output
	S54H/N74H40	dual 4-input positive NAND buffer
Flip-flops	**S54H/N74H71**	JK master-slave flip-flop with AND-OR
	S54H/N74H72	JK master-slave flip-flop
	S54H/N74H73	dual JK master-slave flip-flop
	S54H/N74H74	dual D-type edge-triggered flip-flop
	S54H/N74H76	dual JK master-slave flip-flop
	S54H/N74H101	JK negative edge-triggered flip-flop
	S54H/N74H102	JK negative edge-triggered flip-flop
	S54H/N74H103	dual JK negative edge-triggered flip-flop
	S54H/N74H106	dual JK negative edge-triggered flip-flop
	S54H/N74H108	dual JK negative edge-triggered flip-flop

TTL

S54S/N74S . .series

Gates	**S54S/N74S00**	quadruple 2-input positive NAND gate
	S54S/N74S02	quadruple 2-input positive NOR gate
	S54S/N74S03	quadruple 2-input positive NAND gate with open collector output
	S54S/N74S08	quadruple 2-input positive AND gate
	S54S/N74S09	quadruple 2-input AND gate with open collector output
	S54S/N74S10	triple 3-input positive NAND gate
	S54S/N74S11	triple 3-input positive AND gate
	S54S/N74S15	triple 3-input AND gate with open collector output
	S54S/N74S20	dual 4-input positive NAND gate
	S54S/N74S22	dual 4-input positive NAND gate with open collector output
	S54S/N74S32	quadruple 2-input positive OR gate
	S54S/N74S51	dual 2-wide 2-input AND-OR-invert gate
	S54S/N74S64	4-2-3-2-input AND-OR-invert gate
	S54S/N74S65	4-2-3-2-input AND-OR-invert gate
	S54S/N74S86	quadruple 2-input EXCLUSIVE-OR gate
	S54S/N74S133	13-input NAND gate
	S54S/N74S134	12-input NAND gate with three-state outputs
	N74S135	quadruple EXCLUSIVE-OR/NOR gate
	S54S/N74S260	dual 5-input NOR gate
Buffers, inverters	**S54S/N74S04**	hex inverter
	S54S/N74S05	hex inverter with open collector output
	N74S37	quadruple 2-input positive NAND buffer
	N74S38	quadruple 2-input positive NAND buffer with open collector output
	S54S/N74S40	dual 4-input positive NAND buffer
Flip-flops	**S54S/N74S74**	dual D-type edge-triggered flip-flop
	S54S/N74S112	dual JK negative edge-triggered flip-flop
	S54S/N74S113	dual JK positive edge-triggered flip-flop
	S54S/N74S114	dual JK negative edge-triggered flip-flop
	S54S/N74S174	hex D-type flip-flop with clear
	N74S175	quadruple D-type edge-triggered flip-flop
Shift registers	**N74S172**	16-bit multiple port register file
	N74S178	4-bit parallel access shift register
	N74S179	4-bit parallel access shift register
	N74S194	4-bit bidirectional universal shift register
	N74S195	4-bit parallel-access shift register
Counters	**N74S196**	presettable decade counter/latch
	N74S197	presettable binary counter/latch

Decoders-multiplexers	**N74S138**	3 to 1 of 8 line decoder/demultiplexer
	S54S/N74S139	dual 2 to 10 of 4 line decoder/demultiplexer
	S54S/N74S151	8-line to 1-line multiplexer
	S54S/N74S153	dual 4-line to 1-line multiplexer
	S54S/N74S157	quadruple 2-input data selector (non-inverting)
	S54S/N74S158	quadruple 2-input data selector (inverting)
	N74S251	data selector/multiplexer with three-state outputs
	S54S/N74S253	dual 4-line to 1-line data selector/multiplexer
	N74S257	quadruple 2-line to 1-line data selector/multiplexer
	N74S258	quadruple 2-line to 1-line data selector/multiplexer
Decoders-drivers	**S54S/N74S140**	dual 4-input NAND line driver
Arithmetic units	**S54S/N74S85**	4-bit magnitude comparator
	S54S/N74S181	4-bit arithmetic logic unit
	N74S182	look-ahead carry generator
	N74S280	9-bit odd/even parity generator/checker
	S54S/N74S350	4-bit shifter with three-state outputs

TTL

S54LS/N74LS . .series

Gates	**S54LS/N74LS00**	quadruple 2-input positive NAND gate	
	S54LS/N74LS01	quadruple 2-input positive NAND gate with open collector output	
	S54LS/N74LS02	quadruple 2-input positive NOR gate	
	S54LS/N74LS03	quadruple 2-input positive NAND gate with open collector output	
	S54LS/N74LS08	quadruple 2-input positive AND gate	
	S54LS/N74LS09	quadruple 2-input AND gate with open collector output	
	S54LS/N74LS10	triple 3-input positive NAND gate	
	S54LS/N74LS11	triple 3-input positive AND gate	
	S54LS/N74LS12	triple 3-input NAND gate with open collector output	
	S54LS/N74LS15	triple 3-input AND gate with open collector output	
	S54LS/N74LS20	dual 4-input positive NAND gate	
	S54LS/N74LS21	dual 4-input positive AND gate	
	S54LS/N74LS22	dual 4-input positive NAND gate with open collector output	
	S54LS/N74LS26	quadruple 2-input NAND gate with open collector output	
	S54LS/N74LS27	triple 3-input NOR gate	
	S54LS/N74LS30	8-input positive NAND gate	
	S54LS/N74LS32	quadruple 2-input positive OR gate	
	S54LS/N74LS51	dual 2-wide 2-input AND-OR-invert gate	
	S54LS/N74LS54	4-wide 2-input AND-OR-invert gate	
	S54LS/N74LS55	2-wide 4-input AND-OR-invert gate	
	S54LS/N74LS86	quadruple 2-input EXCLUSIVE-OR gate	
	S54LS/N74LS136	quadruple EXCLUSIVE-OR with open collector output	
	S54LS/N74LS260	dual 5-input NOR gate	
	S54LS/N74LS266	quadruple EXCLUSIVE-NOR	
	S54LS/N74LS386	EXCLUSIVE-OR gate	
Buffers, inverters	**S54LS/N74LS04**	hex inverter	
	S54LS/N74LS05	hex inverter with open collector output	
	S54LS/N74LS28	quadruple 2-input positive NOR buffer	
	S54LS/N74LS33	quadruple 2-input positive NOR buffer with open collector output	
	S54LS/N74LS37	quadruple 2-input positive NAND buffer	
	S54LS/N74LS38	quadruple 2-input positive NAND buffer with open collector output	
	S54LS/N74LS40	dual 4-input positive NAND buffer	
Bus drivers, transceivers	**S54LS/N74LS125**	quadruple bus buffer gate	with three-state output
	S54LS/N74LS126	quadruple bus buffer gate	
	N74LS240	octal line driver receiver	
	N74LS241	octal line driver receiver	
	S54LS/N74LS242	quadruple bus transceiver	
	S54LS/N74LS243	quadruple bus transceiver	
	S54LS/N74LS365	hex 3-state buffer	
	S54LS/N74LS366	hex 3-state inverter	
	S54LS/N74LS367	hex 3-state buffer	
	S54LS/N74LS368	hex 3-state inverter	

Flip-flops	**S54LS/N74LS13**	dual NAND Schmitt trigger
	S54LS/N74LS14	hex Schmitt trigger
	S54LS/N74LS73	dual JK master-slave flip-flop
	S54LS/N74LS74	dual D-type edge triggered flip-flop
	S54LS/N74LS76	dual JK master-slave flip-flop
	S54LS/N74LS78	dual JK negative edge-triggered flip-flop
	S54LS/N74LS107	dual JK master-slave flip-flop
	S54LS/N74LS109	dual JK positive edge-triggered flip-flop
	S54LS/N74LS112	dual JK negative edge-triggered flip-flop
	S54LS/N74LS113	dual JK positive edge-triggered flip-flop
	S54LS/N74LS114	dual JK negative edge-triggered flip-flop
	N74LS123	dual retriggerable monostable multivibrator
	S54LS/N74LS132	quadruple Schmitt trigger
	S54LS/N74LS173	quadruple D-type flip-flop
	S54LS/N74LS174	hex D-type flip-flop with clear
	S54LS/N74LS175	quadruple D-type edge-triggered flip-flop
	S54LS/N74LS221	dual monostable multivibrator
	N74LS273	octal D-type flip-flop with clear
	N74LS377	octal D-type flip-flop with clear
Arithmetic units	**S54LS/N74LS83A**	4-bit binary full adder
	S54LS/N74LS85	4-bit magnitude comparator
	S54LS/N74LS181	4-bit arithmetic logic unit
	S54LS/N74LS261	2 x 4 parallel binary multiplier
	S54LS/N74LS283	4-bit adder
	S54LS/N74LS670	4 x 4 register file (three-state)
Shift registers	**S54LS/N74LS95B**	4-bit right-shift left-shift register
	S54LS/N74LS96	5-bit shift register
	S54LS/N74LS164	8-bit parallel-out serial shift register
	S54LS/N74LS170	4 x 4 register file
	S54LS/N74LS194A	4-bit bidirectional universal shift register
	S54LS/N74LS195A	4-bit parallel-access shift register
	S54LS/N74LS295A	4-bit right-shift left-shift register
	S54LS/N74LS395	4-bit cascadable shift register

TTL

S54LS/N74LS . .series

Counters	**S54LS/N74LS90**	decade counter
	S54LS/N74LS92	divide-by-twelve counter
	S54LS/N74LS93	4-bit binary counter
	S54LS/N74LS161	synchronous 4-bit binary counter
	S54LS/N74LS163	synchronous 4-bit binary counter
	S54LS/N74LS190	synchronous up/down counter (BCD)
	S54LS/N74LS191	synchronous up/down counter (binary)
	S54LS/N74LS192	synchronous decade up/down counter
	S54LS/N74LS193	synchronous 4-bit binary up/down counter
	S54LS/N74LS196	presettable decade counter/latch
	S54LS/N74LS197	presettable binary counter/latch
	S54LS/N74LS290	decade counter
	S54LS/N74LS293	4-bit binary counter
Latches	**S54LS/N74LS75**	quadruple latch
	N74LS273	octal latch
	S54LS/N74LS279	quadruple S-R latch
	S54LS/N74LS375	quadruple latch
Decoders-multiplexers	**S54LS/N74LS42**	BCD-to-decimal decoder
	S54LS/N74LS138	3 to 1 of 8 line decoder/demultiplexer
	S54LS/N74LS139	dual 2-line to 4-line decoder/demultiplexer
	S54LS/N74LS151	8-line to 1-line multiplexer
	S54LS/N74LS153	dual 4-line to 1-line multiplexer
	S54LS/N74LS154	4-line to 16-line decoder/demultiplexer
	S54LS/N74LS155	dual 2-line to 4-line decoder/demultiplexer
	S54LS/N74LS156	dual 2-line to 4-line decoder/demultiplexer
	S54LS/N74LS157	quadruple 2-input data selector (non-inverting)
	S54LS/N74LS158	quadruple 2-input data selector (inverting)
	S54LS/N74LS251	data selector/multiplexer with three-state outputs
	S54LS/N74LS253	dual 4-line to 1-line data selector/multiplexer
	N74LS254	4 to 16 decoder/demultiplexer with three-state output
	S54LS/N74LS257	quadruple 2-line to 1-line data selector/multiplexer
	S54LS/N74LS258	quadruple 2-line to 1-line data selector/multiplexer
	S54LS/N74LS298	quadruple 2-input multiplexer with storage
Decoders-drivers	**S54LS/N74LS145**	high-voltage BCD-to-decimal decoder/driver with open collector output

MSI – S82/N82 and other series

Arithmetic units	**S82/N8260**	arithmetic logic unit
	S82/N8261	fast carry extender
	S82/N8268	gated full adder
Buffers/inverters	**S80/N8095**	hex 3-state buffer
	S80/N8096	hex 3-state inverter
	S80/N8097	hex 3-state buffer
	S80/N8098	hex 3-state inverter
Counters	**S82/N8280**	presettable decade counter
	S82/N8281	presettable binary counter
	S82/N8284	binary up/down counter
	S82/N8285	decade up/down counter
	S82/N8288	divide-by-12 counter
	S82/N8290	high-speed presettable decade counter
	S82/N8291	high-speed presettable binary counter
	S82/N8292	presettable low power decade counter
	S82/N8293	presettable low power binary counter
	S93/N9310	4-bit decade counter
	S93/N9316	4-bit binary counter
Decoders/display drivers	**S82/N8250**	binary-to-octal decoder
	S82/N8251	BCD-to-decimal decoder
	S82/N8252	BCD-to-decimal decoder
Flip-flops	**S96/N9601**	retriggerable monostable multivibrator
	S96/N9602	dual monostable multivibrator
Multiplexers	**S82/N8230**	8-input digital multiplexer
	S82/N8231	8-input digital multiplexer
	S82/N8232	8-input digital multiplexer
	S82/N8233	2-input, 4-bit digital multiplexer
	S82/N8234	2-input, 4-bit digital multiplexer
	S82/N8235	2-input, 4-bit digital multiplexer
	S82/N8263	3-input, 4-bit digital multiplexer
	S82/N8264	3-input, 4-bit digital multiplexer
	S82/N8266	2-input, 4-bit digital multiplexer
	S82/N8267	2-input, 4-bit digital multiplexer
	S93/N9309	dual 4-input multiplexer
	S93/N9312	8-input digital multiplexer
	S93/N9322	data selector multiplexer

TTL

MSI – S82/N82 and other series

Parity functions	**S82/N8241**	quadruple EXCLUSIVE-OR
	S82/N8242	quadruple EXCLUSIVE-NOR
	S82/N8262	9-bit parity generator and checker
	S82/N8269	4-bit comparator
	S93/N9324	5-bit comparator
Registers/latches	**S82/N8200**	dual 5-bit buffer register
	S82/N8201	dual 5-bit buffer register with D complement
	S82/N8202	10-bit buffer register
	S82/N8203	10-bit buffer register with D complement
	S82/N8270	4-bit shift register
	S82/N8271	4-bit shift register
	S82/N8273	10-bit serial-in, parallel-out shift register
	S82/N8274	10-bit parallel-in, serial-out shift register
	S82/N8275	quadruple bistable latch
	S82/N8276	8-bit serial shift register
	S82/N8277	dual 8-bit shift register
	S93/N9300	4-bit shift register
	S93/N9308	dual 4-bit latch with clear
	S93/N9314	quadruple latch
	S93/N9334	8-bit addressable latch
Scaler (Asynchronous shift register)	**S82/N8243**	8-bit position scaler

N82S . .series

Decoders/drivers	**N82S50**	binary-to-octal decoder
	N82S52	BCD-to-decimal decoder
	N82S90	high-speed presettable decimal/binary decoder
	N82S91	high-speed presettable decimal/binary decoder
Multiplexers	**N82S30**	8-input digital multiplexer
	N82S31	8-input digital multiplexer
	N82S32	8-input digital multiplexer
	N82S33	2-input, 4-bit digital multiplexer
	N82S34	2-input, 4-bit digital multiplexer
	N82S66	2-input, 4-bit digital multiplexer
	N82S67	2-input, 4-bit digital multiplexer
Parity functions	**N82S41**	quadruple EXCLUSIVE-OR element
	N82S42	4-bit quadruple EXCLUSIVE-NOR
	N82S62	9-bit parity generator/checker
Shift registers	**N82S70**	high-speed 4-bit shift register
	N82S71	high-speed 4-bit shift register
Arithmetic units	**N82S82**	4-bit BCD arithmetic unit
	N82S83	4-bit BCD adder

TTL

interface — S8T/N8T . .series

Translators/buffers	**S8T/N8T18**	high voltage to TTL translator
	S8T/N8T80	quadruple 2-input NAND gate (high voltage)
	S8T/N8T90	hex inverter (high voltage)
Timing circuits	**S8T/N8T20**	bidirectional one shot
	S8T/N8T22/9601	retriggerable monostable multivibrator
	N8T363	dual zero crossing detector
	S96/N9602	dual retriggerable monostable multivibrator
Line drivers **receivers** **transceivers**	**S8T/N8T09**	quadruple three-state bus driver
	S8T/N8T10	quadruple three-state D-type bus flip-flop
	S8T/N8T13	dual low impedance line driver
	S8T/N8T14	triple line receiver/Schmitt trigger
	S8T/N8T15	dual communications line driver
	S8T/N8T16	dual communications line receiver
	N8T23	dual IBM 360/370 line driver
	N8T24	triple IBM 360/370 line receiver
	N8T25	dual MOS to TTL interface
	S8T/N8T26A	quadruple three-state bus transceiver (inverting)
	S8T/N8T28	quadruple three-state bus transceiver (non-inverting)
	N8T30	dual DTL/TTL to MOS transceiver/port controller
	S8T/N8T31	8-bit bidirectional input/output port
	N8T34	quadruple bus transceiver (three-state outputs)
	S8T/N8T37	hex bus receiver/Schmitt trigger
	N8T38	quadruple bus transceiver (open collector)
	N8T93	high-speed hex inverter
	S8T/N8T94	high-speed hex inverter (open collector)
	S8T/N8T95/97	high-speed hex three-state buffer
	S8T/N8T96/98	high-speed hex three-state inverter
	N8T380	quadruple bus receiver with hysteresis/Schmitt trigger
Decoder drivers	**S8T/N8T04**	7-segment decoder display driver
	S8T/N8T05	7-segment decoder display driver
	S8T/N8T06	7-segment decoder display driver

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Bipolar

For military products
see also pp B231 to B237

	RAM			PROM		
technology	capacity	type	page	capacity	type	page
TTL	16 x 4	**N3101A**	B132-B133	32 x 8	**N82S23**	B134-B135
	16 x 4	**N74S89**		32 x 8	**N82S123**	
	16 x 4	**N74S189**		256 x 4	**N82S27**	
	16 x 4	**N82S25**		256 x 4	**N82S126**	
	256 x 1	**N74S200**		256 x 4	**N82S129**	
	256 x 1	**N74S201**		256 x 8	**N82S114**	
	256 x 1	**N74S301**		512 x 4	**N82S130**	
	256 x 1	**N82S16**		512 x 4	**N82S131**	
	256 x 1	**N82S116**		512 x 8	**N82S115**	
	256 x 1	**N82S17**		512 x 8	**N82S140**	
	256 x 1	**N82S117**		512 x 8	**N82S141**	
	64 x 9	**N82S09**		512 x 8	**N82S146**	
	1k x 1	**N82S10**		512 x 8	**N82S147**	
	1k x 1	**N93415A**		1k x 4	**N82S136**	
	1k x 1	**N82S110**		1k x 4	**N82S137**	
	1k x 1	**N82LS10**		1k x 8	**N82S180**	
	1k x 1	**N82S11**		1k x 8	**N82S181**	
	1k x 1	**N93425A**		1k x 8	**N82S2708**	
	1k x 1	**N82S111**		2k x 4	**N82S184**	
	1k x 1	**N82LS11**		2k x 4	**N82S185**	
	256 x 8	**N82S208**		2k x 8	**N82S190**	
	256 x 9	**N82S210**		2k x 8	**N82S191**	
	4k x 1	**N82S400**				
	4k x 1	**N82S401**				
ECL	16 x 4	**GXB10145**	B136-B137	32 x 8	**GXB10139**	B136-B137
	64 x 1	**GXB10140**		256 x 4	**GXB10149**	
	64 x 1	**GXB10142**				
	64 x 1	**GXB10148**				
	128 x 1	**GXB10405**				
	256 x 1	**GXB10144**				
	256 x 1	**GXB10410**				
	1k x 1	**GXB10415**				

When ordering please quote the ordering code to specify device, temperature range if applicable (prefix N or S), and package (suffix D, E, F, I, K, N, P, T or TA).

Examples:
N82S25N commercial temperature range, plastic DIL package
S82S16F military temperature range, cerdip DIL package
N74S89N commercial temperature range, plastic DIL package
S54S89F military temperature range, cerdip DIL package

	ROM			**specials**			
technology	capacity	type	page	capacity		type	page
TTL	256 x 4	**N82S226**	B136-B137	8 x 4	SAM	**N82S12**	B136-B137
	256 x 4	**N82S229**		8 x 4	SAM	**N82S112**	
	256 x 8	**N82S214**		32 x 2	WWRM	**N82S21**	
	512 x 4	**N82S230**		16 x 48 x 8	FPLA	**N82S100**	
	512 x 4	**N82S231**		16 x 48 x 8	FPLA	**N82S101**	
	512 x 8	**N82S215**		16 x 9	FPGA	**N82S102**	
	512 x 8	**N82S240**		16 x 9	FPGA	**N82S103**	
	512 x 8	**N82S241**		16 x 48 x 8	FPLA	**N82S106**	
	1k x 4	**N8228**		16 x 48 x 8	FPLA	**N82S107**	
	1k x 8	**N82S280**		16 x 48 x 8	PLA	**N82S200**	
	1k x 8	**N82S281**		16 x 48 x 8	PLA	**N82S201**	
	2k x 8	**N82S290**					
	2k x 8	**N82S291**					
ECL				8 x 2	CAM	**GXB10155**	B136-B137

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MOS

technology	RAM capacity	type	page	EPROM capacity	type	page
MOS	**static**					
	256 x 1	**2501**	B138-B139	4k	**2704**	B138-B139
	256 x 1	**25L01**		8k	**2708**	
	256 x 1	**HEF4720B(V)**				
	256 x 4	**2101**				
	256 x 4	**2111**				
	256 x 4	**2112**				
	256 x 4	**2606**				
	256 x 4	**2606-1**				
	1k x 1	**2102**				
	1k x 1	**21F02**				
	1k x 1	**21L02**				
	1k x 1	**2102A/AL**				
	1k x 1	**2115**				
	1k x 1	**2125**				
	1k x 4	**2614**				
	1k x 4	**2624**				
	4k x 1	**2613**				
	4k x 1	**2623**				
	dynamic					
	4k x 1	**2627**	B138-B139			
	4k x 1	**2660**				
	4k x 1	**2680**				
	16k x 1	**2690**				

When ordering please quote the ordering code to specify device, temperature range if applicable (prefix N or S), and package (suffix D, E, F, I, K, N, P, T or TA).

Examples:

N82S25N	commercial temperature range, plastic DIL package
S82S16F	military temperature range, cerdip DIL package
N74S89N	commercial temperature range, plastic DIL package
S54S89F	military temperature range, cerdip DIL package

				shift registers		
technology	capacity	type	page	capacity	type	page
MOS	**ROM**			**static**		
	512 x 8	**2530**	B138-B139	2 x 50	**2509**	**B140**
	1k x 8	**2607**		6 x 32	**2518**	
	1k x 8	**2608**		2 x 100	**2510**	
	2k x 4	**2580**		6 x 40	**2519**	
	2k x 8	**2600**		2 x 128	**2521**	
	2k x 8	**2616**		2 x 132	**2522**	
	2k x 8	**2617**		4 x 80	**2532**	
				2 x 200	**2511**	
				2 x 240	**2529**	
				2 x 250	**2528**	
				2 x 256	**2527**	
				1 x 1k	**2533**	
	character generators			**dynamic**		
	64 x 8 x 5	**2513**	B138-B139	2 x 100	**2506**	B140
	64 x 6 x 8	**2516**		2 x 100	**2507**	
	64 x 9 x 9	**2526**		2 x 100	**2517**	
	128 x 7 x 9	**2609**		1 x 512	**2505**	
				1 x 512	**2524**	
				4 x 256	**2502**	
				2 x 512	**2503**	
				1 x 1k	**2504**	
				1 x 1k	**2512**	
				1 x 1k	**2525**	

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cross reference

Bipolar

AMD	Signetics
2700/27LS00	82S16
2701/27LS01	82S17
27S08/27LS08	82S23
27S09/27LS09	82S123
27S10	82S126
27S11	82S129
2952	82S10/93415A
2953	82S11/93425A
2980	82S101
2981	82S100
3101	82S25
3101A/27S02	3101A

Fairchild	Signetics
10405	GXB10405
10410	GXB10410/10144
10415	GXB10415
10145A	GXB10145
10149	GXB10149
93403	82S25
93406	82S226
93410	74S301
93411	82S17
93411A	82S117
93415	82S10
93415A	93415A
93415B	82S110
93L415	82LS10
93417	82S126
93419	82S09
93421	82S16
93421A	82S116
93425	82S11
93425A	93425A
93425B	82S111
93L425	82LS11
93427	82S129
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93442	82S241
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93448	82S141
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93453	82S137
93454	82S280
93457	82S226
93464	82S281
93467	82S229

Harris	Signetics
0064	82S25
1024/HM7610	82S129
1024A/HM7611	82S126
2048	82S131
2048A	82S130
HM7602/8256	82S23
HM7603	82S123
HM7615	GXB10149
HM7620	82S130
HM7621	82S131
HM7640	82S140
HM7641	82S141
HM7642	82S136
HM7643	82S137
HM7644	82S115 **
HM7699	82S115 **

Intel	Signetics
2708	82S2708
3101	82S25
3101A	3101A
3106/3106A	82S16
3107/3107A	82S17
3301A	82S226
3302	82S230
3304	82S215 **
3322	82S231
3601	82S126
3602	82S130
3604	82S140
3605	82S136
3621	82S129
3622	82S131
3624	82S141
3625	82S137

** Not pin-for-pin compatible.

Intersil	Signetics
5501	82S25
5503	74S301
55S08(A)	82S10
55S18(A)	82S11
5523A	82S16
5533A	82S17
5600	82S23
5603	82S126
5604A	82S130
5605	82S140
56S06	82S136
5610	82S123
5623A	82S129
5624	82S131
5625	82S141
56S26	82S137

Motorola	Signetics
10139	GXB10139
10140	GXB10140
10142	GXB10142
10144	GXB10144/10410
10145	GXB10145
10146/10415	GXB10415
10147	GXB10405
10148	GXB10148
10149	GXB10149
4004A	82S226
4064	82S25
4256	82S16
5005	82S126
68708	82S2708

MMI	Signetics
10149	GXB10149
6200	82S226
6201	82S229
6205	82S230
6206	82S231
6275	82S290
6276	82S291
6280	82S280
6281	82S281
6300-1	82S126
6301-1	82S129
6305-1	82S130
6306-1	82S131
6330	82S23
6331	82S123
6335	82S114 **
6340	82S140
6341	82S141
6348	82S146
6349	82S147
6352	82S136
6353	82S137
6380	82S180
6381	82S181
6385	82S2708
6530	82S17
6531	82S16
6555	82S09
6560	82S25/3101A
6561	74S189
82S100	82S100
82S101	82S101

National Semiconductor	Signetics
74187	82S226
8573	82S126
8574	82S129
8582	82S17
8588	82S23
86L99	82S25

TI	Signetics
2708	82S2708 82S400 82S401
10142	GXB10142
10144	GXB10144/10410
10147	GXB10405
74187	82S226
74S188	82S23
74S189	74S189
74S89	74S89
74S200	74S200
74S201	74S201
74S209	82S11/93425A
74S270	82S230
74S287	82S129
74S288	82S123
74S289	3101A
74S301	74S301
74S309	82S10/93415A
74S370	82S231
74S387	82S126
74S472	82S146
74S473	82S147

** Not pin-for-pin compatible.

memories

cross reference

MOS

AMD	Signetics
2102	2102 21F02 21L02
9216	2617
AM1402APC	2502
AM1403A	2503
AM1404A	2504
AM1507	2517
AM1507T	2506
AM2505K	2505
AM2806HC	2512
AM2807PC	2524
AM2808PC	2525
AM2809	2521
AM2833PC	2533
AM9060	2680
P1101	2501

Electronic Arrays	Signetics
4600	2600
4900	2600

Fairchild	Signetics
2102	2102 21F02 21L02
3343	2521
3344	2522
3347	2532
3349	2518
3533	2533
F4720	HEF4720B

General Instruments	Signetics
2509	2509
2510	2510
2511	2511
2513	2513
2516	2516
2530	2530
2533	2533
2580	2580

Intel	Signetics
2101	2101
2102A	2102 21F02 21L02 2102A
2102AL	2102AL
2107B	2680
2111	2111
2112	2112
2114	2614
2115	2115
2116A	2690
2125	2125
2308	2607
2316E	2616
2704	2704
2708	2607 2708
C1402A	2502
C1403A	2503
M1404A	2504
M1405A	2505
P1101	2501

Intersil	Signetics
IM7501	2501
IM7552	2102
	21F02
	21L02
IM7712C	2512
IM7722C	2525
IM7780C	2532

Mostek	Signetics
29000	2600
MK1007P	2532
MK4007	2501
	25L01
MK4027	2627
MK4096	2660
MK4102	2102
	21F02
	21L02
MK4116	2690

Motorola	Signetics
6570	2609
6830	2608

National Semiconductor	Signetics
MM1101	2501
MM1402A	2502
MM1403A	2503
MM1404A	2504
MM1506H	2506
MM1507H	2517
MM2102	2102
	21F02
	21L02
MM2521	2521
MM2522	2522
MM5058	2533
MM5280	2680

Synertex	Signetics
2316B	2616
4600	2600

Texas Instruments	Signetics
TMS3112NC	2518
TMS3120NC	2532
TMS3128NC	2521
TMS3129NC	2522
TMS3133NC	2533
TMS4035	2102
	21F02
	21L02
TMS4030	2680
TMS4060	2680

Bipolar

Output structure: OC open collector
TS three-state

	capacity	type	output structure	no. of pins	tAA max ns	input current µA	supply voltage V	max supply current mA	packages
TTL-RAM	16 x 4	**N3101A ***	OC	16	35	100	5	105	N, F
	16 x 4	**N74S89**	OC	16	50	100	5	105	N, F
	16 x 4	**N74S189**	TS	16	35	250	5	110	N, F
	16 x 4	**N82S25**	OC	16	50	100	5	105	N, F
	256 x 1	**N74S200**	TS	16	50	100	5	130	N, F
	256 x 1	**N74S201**	TS	16	50	100	5	130	N, F
	256 x 1	**N74S301**	OC	16	50	100	5	130	N, F
	256 x 1	**N82S16**	TS	16	50	100	5	115	N, F
	256 x 1	**N82S17**	OC	16	50	100	5	115	N, F
	256 x 1	**N82S116**	TS	16	40	100	5	115	N, F
	256 x 1	**N82S117**	OC	16	40	100	5	115	N, F
	64 x 9	**N82S09**	OC	28	45	100	5	190	N, I
	1024 x 1	**N82S10**	OC	16	45	100	5	170	N, F
	1024 x 1	**N82S11**	TS	16	45	100	5	170	N, F
	1024 x 1	**N82S110**	OC	16	35	100	5	170	N, F
	1024 x 1	**N82S111**	TS	16	35	100	5	170	N, F
	1024 x 1	**N93415A**	OC	16	45	100	5	170	N, F
	1024 x 1	**N93425A**	TS	16	45	100	5	170	N, F
	1024 x 1	**N82LS10 ***	OC	16	60	100	5	60	N, F
	1024 x 1	**N82LS11 ***	TS	16	60	100	5	60	N, F
	256 x 8	**N82S208**	TS	22	60	100	5	185	N, F
	256 x 9	**N82S210**	TS	24	60	100	5	185	N, F
	4096 x 1	**N82S400 ***	OC	18	70	150	5	155	I
	4096 x 1	**N82S401 ***	TS	18	70	150	5	155	I

* In development.

Military versions of industrial ICs with prefix N have S as a prefix. **Example:** industrial version N82S25, military version S82S25. The specifications shown below apply to industrial versions. There is generally some derating in specification for military versions due to the extended temperature range.

Temperature ranges

C 0 to 75 °C
M −55 to +125 °C

chip enable lines	temp. range	pin compatible types ▲ = fully compatible	second sourced by	pin diagram on page
1	M, C	82S25, 74S89	AMD, Intel, MMI, TI	B148
1	M, C	N3101A, 82S25	TI	
1	M, C	–	MMI, TI	
1	M, C	N3101A, 74S89	AMD, Fch, Harris, Intel, Intersil, MMI, Mot, National	
3	M, C	82S16, 82S116, 74S201 ▲	TI	B146
3	M, C	82S16, 82S116, 74S200 ▲	TI	
3	M, C	82S17, 82S117	Fch, Intersil, TI	
3	M, C	82S116, 74S200, 74S201	AMD, Fch, Intel, Intersil, MMI, Mot	
3	M, C	82S117, 82S301	AMD, Fch, Intel, Intersil, MMI	
3	C	82S16, 74S200, 74S201	Fch	B146
3	C	82S17, 74S301	Fch	B146
1	M, C	–	Fch, MMI	B149
1	M, C	82S110, 93415A ▲, 82LS10	AMD, Fch, Intersil, TI	B147
1	M, C	82S111, 93425A, 82LS11	AMD, Fch, Intersil, TI	B147
1	C	82S10, 93415A, 82LS10	Fch	B147
1	C	82S11, 93425A, 82LS11	Fch	
1	C	82S10 ▲, 82S110, 82LS10	AMD, Fch, TI	
1	C	82S11 ▲, 82S111, 82LS11	AMD, Fch, TI	
1	C	82S10, 93415A, 82S110	Fch	
1	C	82S11, 93425A, 82S111	Fch	B147
1	C	–	–	B149
1	C	–	–	B149
1	C	–	TI	B147
1	C	–	TI	B147

memories

technical data

Bipolar

Output structure: OC open collector
TS three-state

	capacity	type	output structure	no. of pins	t_{AA} max ns	input current µA	supply voltage V	max supply current mA	packages
TTL-PROM	32 x 8	**N82S23**	OC	16	50	100	5	77	N, F
	32 x 8	**N82S123**	TS	16	50	100	5	77	N, F
	256 x 4	**N82S27**	OC	16	40	1600	5	140	F
	256 x 4	**N82S126**	OC	16	50	100	5	120	N, F
	256 x 4	**N82S129**	TS	16	50	100	5	120	N, F
	256 x 8	**N82S114**	TS	24	60	100	5	180	N, F
	512 x 4	**N82S130**	OC	16	50	100	5	140	N, F
	512 x 4	**N82S131**	TS	16	50	100	5	140	N, F
	512 x 8	**N82S115**	TS	24	60	100	5	180	N, F
	512 x 8	**N82S140**	OC	24	60	100	5	175	N, F
	512 x 8	**N82S141**	TS	24	60	100	5	175	N, F
	512 x 8	**N82S146 ***	OC	20	45	—	5	—	N
	512 x 8	**N82S147 ***	TS	20	45	—	5	—	N
	1024 x 4	**N82S136**	OC	18	60	100	5	140	F
	1024 x 4	**N82S137**	TS	18	60	100	5	140	F
	1024 x 8	**N82S180**	OC	24	70	100	5	150	F
	1024 x 8	**N82S181**	TS	24	70	100	5	150	F
	1024 x 8	**N82S2708**	TS	24	70	100	5	150	F
	2048 x 4	**N82S184**	OC	18	100	100	5	120	I
	2048 x 4	**N82S185**	TS	18	100	100	5	120	I
	2048 x 8	**N82S190**	OC	24	80	100	5	175	N, F
	2048 x 8	**N82S191**	TS	24	80	100	5	175	N, F

* In development.

Military versions of industrial ICs with prefix N have S as a prefix. **Example:** industrial version N82S25, military version S82S25. The specifications shown below apply to industrial versions. There is generally some derating in specification for military versions due to the extended temperature range.

Temperature ranges

C 0 to 75 °C

M −55 to +125 °C

chip enable lines	temp. range	pin compatible types ▲ = fully compatible	second sourced by	pin diagram on page
1	M, C	–	AMD, Harris, Intersil, MMI, National, TI	B143
1	M, C	–	AMD, Harris, Intersil, MMI, TI	B143
2	C	82S126, 82S226	–	B141
2	M, C	82S226 ▲, 82S27	AMD, Fch, Harris, Intel, Intersil, MMI, Mot, National, TI	B141
2	M, C	82S229 ▲	AMD, Fch, Harris, Intel, Intersil, MMI, National, TI	B141
2	M, C	82S214 ▲	MMI **	B143
1	M, C	82S230 ▲	Fch, Harris, Intel, Intersil, MMI	B141
1	M, C	82S231 ▲	Fch, Harris, Intel, Intersil, MMI	B141
2	M, C	82S215 ▲	Harris **	B144
4	M, C	82S240 ▲	Fch, Harris, Intel, Intersil, MMI	
4	M, C	82S241 ▲	Fch, Harris, Intel, Intersil, MMI	
1	C	–	MMI, TI **	
1	C	–	MMI, TI **	
2	M, C	–	Fch, Harris, Intel, Intersil, MMI	B142
2	M, C	–	Fch, Harris, Intel, Intersil, MMI	B142
4	M, C	82S280 ▲	MMI	B145
4	M, C	82S281 ▲	MMI	B145
1	M, C	–	MMI, (EPROM – Intel, Mot, TI)	B145
1	M, C	–	–	B142
1	M, C	–	–	B142
3	C	82S290 ▲	–	B145
3	C	82S291 ▲	–	B145

** Not pin-for-pin compatible.

memories

technical data

Bipolar

Output structure: OC open collector — TP totem pole — OE open emitter — TS three-state

	capacity	type	output structure	no. of pins	t_{AA} max ns	input current µA	supply voltage V	max supply current mA	packages
TTL-ROM	256 x 4	**N82S226**	OC	16	50	100	5	120	N, F
	256 x 4	**N82S229**	TS	16	50	100	5	120	N, F
	256 x 8	**N82S214**	TS	24	60	100	5	175	F
	512 x 4	**N82S230**	OC	16	50	100	5	135	F
	512 x 4	**N82S231**	TS	16	50	100	5	135	F
	512 x 8	**N82S215**	TS	24	60	100	5	175	F
	512 x 8	**N82S240**	OC	24	60	100	5	175	F
	512 x 8	**N82S241**	TS	24	60	100	5	175	F
	1024 x 4	**N8228**	TP	16	70	400	5	170	F, I
	1024 x 8	**N82S280**	OC	24	70	100	5	150	I
	1024 x 8	**N82S281**	TS	24	70	100	5	150	I
	2048 x 8	**N82S290**	OC	24	70	100	5	170	F
	2048 x 8	**N82S291**	TS	24	70	100	5	170	F
TTL-SAM	8 x 4	**N82S12**	OC	24	35	250	5	160	N, F
	8 x 4	**N82S112**	TS	24	35	250	5	160	N, F
TTL-WWRM	32 x 2	**N82S21**	OC	16	50	1600	5	130	N, F
TTL-FPLA	16 x 48 x 8	**N82S100**	TS	28	50	100	5	170	N, I
	16 x 48 x 8	**N82S101**	OC	28	50	100	5	170	N, I
	16 x 48 x 8	**N82S106**	OC	28	50	100	5	170	N, I
	16 x 48 x 8	**N82S107**	TS	28	50	100	5	170	N, I
TTL-FPGA	16 x 9	**N82S102**	OC	28	30	100	5	170	N, I
	16 x 9	**N82S103**	TS	28	30	100	5	170	N, I
TTL-PLA	16 x 48 x 8	**N82S200**	TS	28	50	100	5	170	N, I
	16 x 48 x 8	**N82S201**	OC	28	50	100	5	170	N, I
ECL-RAM	64 x 1	**GXB10140**	OE	16	15	265	5,2	80 (typ)	D, P
	64 x 1	**GXB10142**	OE	16	10	265	5,2	100	D, P
	64 x 1	**GXB10148**	OE	16	15	265	5,2	80 (typ)	D, P
	16 x 4	**GXB10145**	OE	16	—	220	5,2	145	D, P
	128 x 1	**GXB10405**	OE	16	15	200	5,2	110	E
	256 x 1	**GXB10144**	OE	16	30	200	5,2	112	D, E
	256 x 1	**GXB10410**	OE	16	35	220	5,2	125	E
	1024 x 1	**GXB10415** *	OE	16	25	—	5,2	—	E
ECL-PROM	32 x 8	**GXB10139**	OE	16	20	265	5,2	145	D
	256 x 4	**GXB10149**	OE	16	20	265	5,2	150	D, E
ECL-CAM	8 x 2	**GXB10155**	OE	18	13	220	5,2	140	E

* In development.

Military versions of industrial ICs with prefix N have S as a prefix.
Example: industrial version N82S25, military version S82S25.
The specifications shown below apply to industrial versions. There is generally some derating in specification for military versions due to the extended temperature range.

Temperature ranges
TTL – C – 0 to 75 °C
TTL – M – –55 to +125 °C
ECL – C – –30 to + 85 °C

chip enable lines	temp. range	pin compatible types ▲ = fully compatible	second sourced by	pin diagram on page
2	M, C	N82S126 ▲, N82S27	Fch, Intel, MMI, Mot, National, TI	B141
2	M, C	N82S129 ▲	Fch, MMI	B141
2	M, C	N82S114	–	B143
1	M, C	N82S130 ▲	Fch, Intel, MMI, TI	B141
1	M, C	N82S131 ▲	Fch, Intel, MMI, TI	B141
2	M, C	N82S115 ▲	–	B144
4	C	N82S140 ▲	–	B144
4	C	N82S141 ▲	Fch	B144
–	C	–	–	B142
4	M, C	N82S180 ▲	Fch, MMI	B145
4	M, C	N82S181 ▲	Fch, MMI	
3	C	N82S190 ▲	MMI	
3	C	N82S191 ▲	MMI	
2 wr. en.	C	–	–	B150
2 wr. en.	C	–	–	
–	C	–	–	B150
1	M, C	N82S200 ▲	AMD, MMI	B151
1	M, C	N82S201 ▲	AMD, MMI	
–	C	–	–	
–	C	–	–	
1	M, C	–	–	B151
1	M, C	–	–	
1	M, C	N82S100	–	B151
1	M, C	N82S101	–	
2	C	GXB10142, GXB10148	Mot	B146
2	C	GXB10140, GXB10148	Mot, TI	B146
2	C	GXB10140, GXB10142	Mot	B146
1	C	–	Fch, Mot	B148
–	C	–	Mot, TI	B146
3	C	GXB10410	Fch, Mot, TI	B146
3	C	GXB10144	Fch, Mot, TI	B146
–	C	–	Fch, Mot	B147
1	C	–	Mot	B143
1	C	–	Fch, Harris, MMI, Mot	B141
–	C	–	–	B150

memories

technical data

MOS

	capacity	type	no. of pins	t_{AA} typ ns	supply voltage V
Static RAM	256 x 1	**2501**	16	1000	+5, −9
	256 x 1	**25L01**	16	1000	+5, −12
	256 x 4	**2101**	22	450 – 1000	+5
	256 x 4	**2111**	18	450 – 1000	+5
	256 x 4	**2112**	16	450 – 1000	+5
	256 x 4	**2606**	16	750	+5
	256 x 4	**2606-1**	16	500	+5
	1024 x 1	**2102**	16	500 – 1000	+5
	1024 x 1	**21F02**	16	250 – 450	+5
	1024 x 1	**21L02**	16	400 – 1000	+5
	1024 x 1	**2102A/AL**	16	150 – 650	+5
	1024 x 1	**2115**	16	35 – 75	+5
	1024 x 1	**2125**	16	35 – 75	+5
	1024 x 4	**2614 ***	18		+5
	1024 x 4	**2624 ***	18		+5
	4096 x 1	**2613 ***	18		+5
	4096 x 1	**2623 ***	18		+5
LOCMOS static RAM	256 x 1	**HEF4720B(V)**	16	150 – 450	+3 to +15
Dynamic RAM	4096 x 1	**2660**	16	200 – 350	+12, +5, −5
	4096 x 1	**2680**	22	200 – 350	+12, +5, −5
	4096 x 1	**2627**	16	150 – 250	+12, +5, −5
	16384 x 1	**2690 ***	16	150 – 250	+12, +5, −5
ROMs and character generators p-channel	512 x 8	**2530**	24	700	+5, −12
	2048 x 4	**2580**	24	950	+5, −12
	64 x 8 x 5	**2513**	24	600	+5, −12
	64 x 6 x 8	**2516**	24	600	+5, −12
	64 x 9 x 9	**2526**	24	700	+5, −12
n-channel	1024 x 8	**2607**	24	450	+5
	1024 x 8	**2608**	24	550	+5
	2048 x 8	**2600**	24	300	+5
	2048 x 8	**2616**	24	300	+5
	2048 x 8	**2617**	24	450	+5
	4096 x 8	**2632 ***	24		+5
	4096 x 8	**2633 ***	24		+5
	128 x 7 x 9	**2609**	24	500	+5
EPROM	4096	**2704**	24	450	+12, +5, −5
	8192	**2708**	24	450	+12, +5, −5

* In development.

Temperature range
C = 0 to +70 °C
XC = –40 to +85 °C

chip enable lines	temp. range	pin compatible types	second sourced by	pin diagram on page
–	C	25L01	AMD, Intel, Intersil, Mostek, National	B152
1	C	2501	Mostek	B152
2	C	–	Intel	B154
2	C	–	Intel	B154
1	C	–	Intel	B155
1	C	2606-1	–	B155
1	C	2606	–	B155
1	C	21F02, 21L02, 2102A/AL	AMD, Fch, Intel, Intersil, Mostek, National, TI	B152
1	C	2102, 21L02, 2102A/AL		B152
1	C	2102, 21F02, 2102A/AL		B152
1	C	2102, 21F02, 21L02	Intel	B152
1	C	2125	Intel	B153
1	C	2115	Intel	B153
–	C	2624	Intel	B155
–	C	2614	Intel	B155
–	C	2623	Intel	B153
–	C	2613	Intel	
1	XC	–	Fch	B152
1	C	–	Mostek	B156
1	C	–	AMD, Intel, National, TI	
1	C	–	Mostek	
1	C	–	Intel, Mostek	
1	C	–	GI	B157
4	C	–	GI	B158
1	C	–	GI	B160
1	C	–	GI	B160
1	C	–	–	B160
2	C	–	Intel	B157
4	C	–	Motorola	B157
2	C	–	Electronic Arrays, Mostek, Synertex	B158
3	C	–	Intel, Synertex	B159
3	C	–	AMD	B159
–	C	–	–	B159
–	C	–	will be industry standard	–
4	C	–	Motorola	B161
1	C	–	Intel	B161
1	C	–	Intel	

memories

technical data

MOS

Several types can be made available
in Cerdip (F package) and metal ceramic
(I package).

Static shift registers – one clock (TTL compatible)
– power supplies +5 and –12 V; 2509/10/11 also –5 V

capacity	type	output structure	on-chip recirculate	package leads	typ speed MHz	second sourced by	pin diagram on page
hex 32 bits	2518	bare drain	yes	N-16	3,0	Fch, TI	B162
hex 40 bits	2519	bare drain	yes	N-16	3,0	–	B162
dual 50 bits	2509	three-state	yes	N-14, K	3,0	GI	B162
quad 80 bits	2532	push-pull	yes	N-16	3,0	Fch, Intersil, Mostek, TI	B163
dual 100 bits	2510	three-state	yes	N-14, K	3,0	GI	B162
dual 128 bits	2521	push-pull	yes	N-8	3,0	AMD, Fch, National, TI	B163
dual 132 bits	2522	push-pull	yes	N-8	3,0	Fch, National, TI	B163
dual 200 bits	2511	three-state	yes	N-14, K	3,0	GI	B162
dual 240 bits	2529	push-pull	yes	N-8	3,0	–	B163
dual 250 bits	2528	push-pull	yes	N-8	3,0	–	B163
dual 256 bits	2527	push-pull	yes	N-8	3,0	–	B163
1024 bits	2533	push-pull	jumper	N-8	2,0	AMD, Fch, GI, National, TI	B163

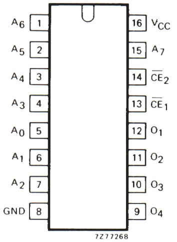
Dynamic shift registers – two clocks (not TTL compatible)
– power supplies +5 and –5 V

capacity	type	output structure	on-chip recirculate	package leads	typ speed MHz	second sourced by	pin diagram on page
dual 100 bits	2517	20 kΩ PD	no	T, N-8	4,0	AMD, National	B164
dual 100 bits	2507	7,5 kΩ PD	no	T, N-8	4,0		
dual 100 bits	2506	bare drain	no	T, N-8	4,0	AMD, National	
quad 256 bits	2502	bare drain	no	N-16	10,0	AMD, Intel, National	B164
512 bits	2524	bare drain	yes	N-8	5,0	AMD	B164
512 bits	2505	bare drain	yes	K	3,0	AMD, Intel	B165
dual 512 bits	2503	bare drain	no	TA, N-8	10,0	AMD, Intel, National	B165
1024 bits	2525	bare drain	yes	N-8	5,0	AMD, Intersil	B164
1024 bits	2512	bare drain	yes	K	3,0	AMD, Intersil	B165
1024 bits	2504	bare drain	no	TA, N-8	10,0	AMD, Intel, National	B165

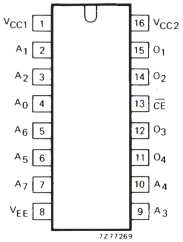
pin diagrams — second sources

Bipolar

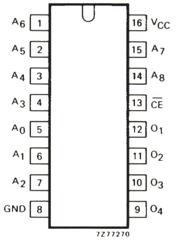
ROMs and PROMs 4 bits wide


A_6 1
A_5 2
A_4 3
A_3 4
A_0 5
A_1 6
A_2 7
GND 8
16 V_{CC}
15 A_7
14 $\overline{CE}_2$
13 $\overline{CE}_1$
12 O_1
11 O_2
10 O_3
9 O_4
7Z77268

type	capacity/output structure	second source
82S27	256 x 4 PROM/OC	–
82S126	256 x 4 PROM/OC	AMD 27S10, Fch 93417, Harris 1024A/7611, Intel 3601, Intersil 5603, MMI 6300-1, Mot 5005, National 8573, TI 74S387
82S129	256 x 4 PROM/TS	AMD 27S11, Fch 93427, Harris 1024/HM7610, Intel 3621, Intersil 5623A, MMI 6301-1, National 8574, TI 74S287
82S226	256 x 4 ROM/OC	Fch 93406, Intel 3301A, MMI 6200, Mot 4004A, National 74187, TI 74187
82S229	256 x 4 ROM/TS	Fch 93467, MMI 6201


V_{CC1} 1
A_1 2
A_2 3
A_0 4
A_6 5
A_5 6
A_7 7
V_{EE} 8
16 V_{CC2}
15 O_1
14 O_2
13 $\overline{CE}$
12 O_3
11 O_4
10 A_4
9 A_3
7Z77269

GXB10149	256 x 4 PROM/OE	Fch 10149, Harris HM7615, MMI 10149, Mot 10149


A_6 1
A_5 2
A_4 3
A_3 4
A_0 5
A_1 6
A_2 7
GND 8
16 V_{CC}
15 A_7
14 A_8
13 $\overline{CE}$
12 O_1
11 O_2
10 O_3
9 O_4
7Z77270

82S130	512 x 4 PROM/OC	Fch 93436, Harris HM7620, Intel 3602, Intersil 5604A, MMI 6305-1
82S131	512 x 4 PROM/TS	Fch 93446, Harris HM7621, Intel 3622, Intersil 5624, MMI 6306-1
82S230	512 x 4 ROM/OC	Fch 93431, Intel 3302, MMI 6205, TI 74S270
82S231	512 x 4 ROM/TS	Fch 93441, Intel 3322, MMI 6206, TI 74S370

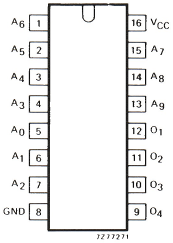
memories

pin diagrams — second sources

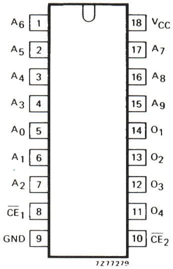
Bipolar

ROMs and PROMs 4 bits wide

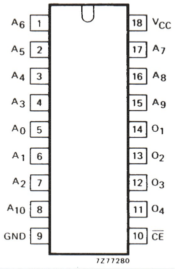
type	capacity/output structure	second source
8228	1024 x 4 ROM/TP	–
82S136	1024 x 4 PROM/OC	Fch 93452, Harris HM7642, Intel 3605, Intersil 56S06, MMI 6352
82S137	1024 x 4 PROM/TS	Fch 93453, Harris HM7643, Intel 3625, Intersil 56S26, MMI 6353
82S184	2048 x 4 PROM/OC	–
82S185	2048 x 4 PROM/TS	–



A_6 1
A_5 2
A_4 3
A_3 4
A_0 5
A_1 6
A_2 7
GND 8
16 V_{CC}
15 A_7
14 A_8
13 A_9
12 O_1
11 O_2
10 O_3
9 O_4
7Z77271



A_6 1
A_5 2
A_4 3
A_3 4
A_0 5
A_1 6
A_2 7
$\overline{CE}_1$ 8
GND 9
18 V_{CC}
17 A_7
16 A_8
15 A_9
14 O_1
13 O_2
12 O_3
11 O_4
10 $\overline{CE}_2$
7Z77279

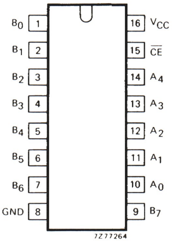


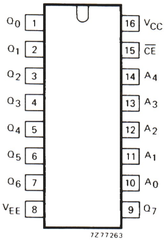
A_6 1
A_5 2
A_4 3
A_3 4
A_0 5
A_1 6
A_2 7
A_{10} 8
GND 9
18 V_{CC}
17 A_7
16 A_8
15 A_9
14 O_1
13 O_2
12 O_3
11 O_4
10 $\overline{CE}$
7Z77280

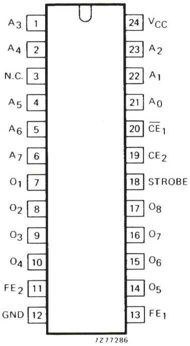
ROMs and PROMs 8 bits wide

type	capacity/output structure	second source
82S23	32 x 8 PROM/OC	AMD 27S08/27LS08, Harris HM7602/8256, Intersil 5600, MMI 6330, National 8588, TI 74S188
82S123	32 x 8 PROM/TS	AMD 27S09/27LS09, Harris HM7603, Intersil 5610, MMI 6331, TI 74S288
GXB10139	32 x 8 PROM/OE	Mot 10139
82S114	256 x 8 PROM/TS	MMI 6335**
82S214	256 x 8 ROM/TS	

** Not pin-for-pin compatible.


B_0 1
B_1 2
B_2 3
B_3 4
B_4 5
B_5 6
B_6 7
GND 8
16 V_{CC}
15 $\overline{CE}$
14 A_4
13 A_3
12 A_2
11 A_1
10 A_0
9 B_7
7Z77264

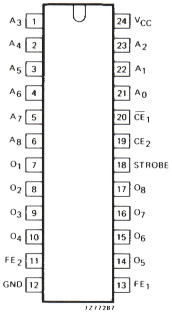

O_0 1
O_1 2
O_2 3
O_3 4
O_4 5
O_5 6
O_6 7
V_{EE} 8
16 V_{CC}
15 $\overline{CE}$
14 A_4
13 A_3
12 A_2
11 A_1
10 A_0
9 O_7
7Z77263

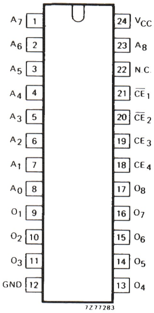

A_3 1
A_4 2
N.C. 3
A_5 4
A_6 5
A_7 6
O_1 7
O_2 8
O_3 9
O_4 10
FE_2 11
GND 12
24 V_{CC}
23 A_2
22 A_1
21 A_0
20 $\overline{CE}_1$
19 CE_2
18 STROBE
17 O_8
16 O_7
15 O_6
14 O_5
13 FE_1
7Z77286

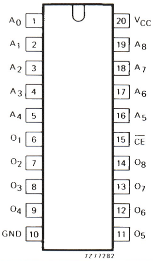
pin diagrams — second sources

Bipolar

ROMs and PROMs 8 bits wide

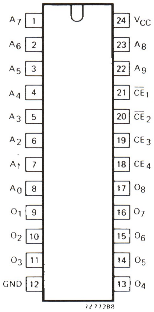

A3 1
A4 2
A5 3
A6 4
A7 5
A8 6
O1 7
O2 8
O3 9
O4 10
FE2 11
GND 12
24 VCC
23 A2
22 A1
21 A0
20 $\overline{CE}_1$
19 CE2
18 STROBE
17 O8
16 O7
15 O6
14 O5
13 FE1
7Z77287


A7 1
A6 2
A5 3
A4 4
A3 5
A2 6
A1 7
A0 8
O1 9
O2 10
O3 11
GND 12
24 VCC
23 A8
22 N.C.
21 $\overline{CE}_1$
20 $\overline{CE}_2$
19 CE3
18 CE4
17 O8
16 O7
15 O6
14 O5
13 O4
7Z77283

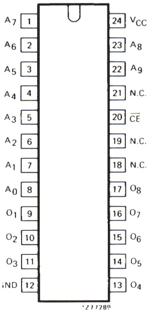

A0 1
A1 2
A2 3
A3 4
A4 5
O1 6
O2 7
O3 8
O4 9
GND 10
20 VCC
19 A8
18 A7
17 A6
16 A5
15 $\overline{CE}$
14 O8
13 O7
12 O6
11 O5
7Z77282

type	capacity/output structure	second source
82S115	512 x 8 PROM/TS	Harris HM7644**/HM7699**
82S215	512 x 8 ROM/TS	—
82S140	512 x 8 PROM/OC	Fch 93438, Harris HM7640, Intel 3604, Intersil 5605, MMI 6340
82S141	512 x 8 PROM/TS	Fch 93448, Harris HM7641, Intel 3624, Intersil 5625, MMI 6341
82S240	512 x 8 ROM/OC	—
82S241	512 x 8 ROM/TS	Fch 93442
82S146	512 x 8 PROM/OC	MMI 6348, TI 74S472**
82S147	512 x 8 PROM/TS	MMI 6349, TI 74S473**

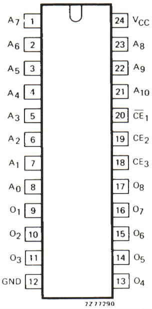
** Not pin-for-pin compatible.


A_7 1
A_6 2
A_5 3
A_4 4
A_3 5
A_2 6
A_1 7
A_0 8
O_1 9
O_2 10
O_3 11
GND 12
24 V_{CC}
23 A_8
22 A_9
21 $\overline{CE}_1$
20 $\overline{CE}_2$
19 CE_3
18 CE_4
17 O_8
16 O_7
15 O_6
14 O_5
13 O_4
7Z77288

type	capacity/output structure	second source
82S180	1024 x 8 PROM/OC	MMI 6380
82S181	1024 x 8 PROM/TS	MMI 6381
82S280	1024 x 8 ROM/OC	Fch 93454, MMI 6280
82S281	1024 x 8 ROM/TS	Fch 93464, MMI 6281


A_7 1
A_6 2
A_5 3
A_4 4
A_3 5
A_2 6
A_1 7
A_0 8
O_1 9
O_2 10
O_3 11
GND 12
24 V_{CC}
23 A_8
22 A_9
21 N.C.
20 $\overline{CE}$
19 N.C.
18 N.C.
17 O_8
16 O_7
15 O_6
14 O_5
13 O_4
7Z77289

82S2708	1024 x 8 PROM/TS	MMI6385, EPROM – Intel 2708, Mot 68708, TI 2708


A_7 1
A_6 2
A_5 3
A_4 4
A_3 5
A_2 6
A_1 7
A_0 8
O_1 9
O_2 10
O_3 11
GND 12
24 V_{CC}
23 A_8
22 A_9
21 A_{10}
20 $\overline{CE}_1$
19 CE_2
18 CE_3
17 O_8
16 O_7
15 O_6
14 O_5
13 O_4
7Z77290

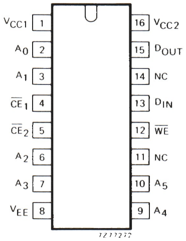
82S190	2048 x 8 PROM/OC	–
82S191	2048 x 8 PROM/TS	–
82S290	2048 x 8 ROM/OC	MMI 6275
82S291	2048 x 8 ROM/TS	MMI 6276

memories

pin diagrams — second sources

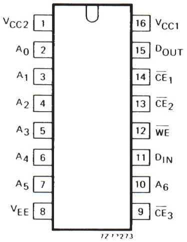
Bipolar

RAMs 1 bit wide



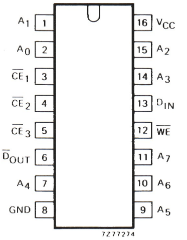
V_{CC1} 1
A_0 2
A_1 3
$\overline{CE}_1$ 4
$\overline{CE}_2$ 5
A_2 6
A_3 7
V_{EE} 8
16 V_{CC2}
15 D_{OUT}
14 NC
13 D_{IN}
12 $\overline{WE}$
11 NC
10 A_5
9 A_4
7Z77272

type	capacity/output structure	second source
GXB10140	64 x 1/OE	Mot 10140
GXB10142	64 x 1/OE	Mot 10142, TI 10142
GXB10148	64 x 1/OE	Mot 10148



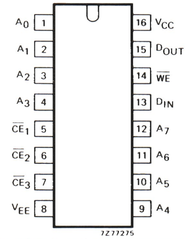
V_{CC2} 1
A_0 2
A_1 3
A_2 4
A_3 5
A_4 6
A_5 7
V_{EE} 8
16 V_{CC1}
15 D_{OUT}
14 $\overline{CE}_1$
13 $\overline{CE}_2$
12 $\overline{WE}$
11 D_{IN}
10 A_6
9 $\overline{CE}_3$
7Z77273

type	capacity/output structure	second source
GXB10405	128 x 1/OE	Mot 10147, TI 10147



A_1 1
A_0 2
$\overline{CE}_1$ 3
$\overline{CE}_2$ 4
$\overline{CE}_3$ 5
$\overline{D}_{OUT}$ 6
A_4 7
GND 8
16 V_{CC}
15 A_2
14 A_3
13 D_{IN}
12 $\overline{WE}$
11 A_7
10 A_6
9 A_5
7Z77274

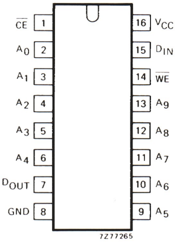
type	capacity/output structure	second source
74S200	256 x 1/TS	TI 74S200
74S201	256 x 1/TS	TI 74S201
74S301	256 x 1/OC	Fch 93410, Intersil 5503, TI 74S301
82S16	256 x 1/TS	AMD 2700/27LS00, Fch 93421, Intel 3106/3106A, Intersil 5523A, MMI 6531, Mot 4256
82S116	256 x 1/TS	Fch 93421A
82S17	256 x 1/OC	AMD 2701/27LS01, Fch 93411, Intel 3107/3107A, Intersil 5533A, MMI 6530
82S117	256 x 1/OC	Fch 93411A



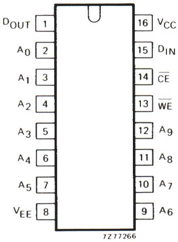
A_0 1
A_1 2
A_2 3
A_3 4
$\overline{CE}_1$ 5
$\overline{CE}_2$ 6
$\overline{CE}_3$ 7
V_{EE} 8
16 V_{CC}
15 D_{OUT}
14 $\overline{WE}$
13 D_{IN}
12 A_7
11 A_6
10 A_5
9 A_4
7Z77275

type	capacity/output structure	second source
GXB10144	256 x 1/OE	Fch 10410, Mot 10144, TI 10144
GXB10410	256 x 1/OE	Fch 10410, Mot 10144, TI 10144

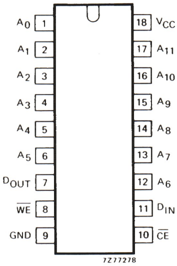
RAMs 1 bit wide


CE
A0
A1
A2
A3
A4
DOUT
GND
1
2
3
4
5
6
7
8
16
15
14
13
12
11
10
9
VCC
DIN
WE
A9
A8
A7
A6
A5
7Z77265

type	capacity/output structure	second source
82S10	1024 x 1/OC	AMD 2952, Fch 93415, Intersil 55S08(A), TI 74S309
82S110	1024 x 1/OC	Fch 93415B
82S11	1024 x 1/TS	AMD 2953, Fch 93425, Intersil 55S18(A), TI 74S209
82S111	1024 x 1/TS	Fch 93425B
82LS10	1024 x 1/OC	Fch 93L415
82LS11	1024 x 1/TS	Fch 93L425
93415A	1024 x 1/OC	AMD 2952, Fch 93415A, TI 74S309
93425A	1024 x 1/TS	AMD 2953, Fch 93425A, TI 74S209


DOUT
A0
A1
A2
A3
A4
A5
VEE
1
2
3
4
5
6
7
8
16
15
14
13
12
11
10
9
VCC
DIN
CE
WE
A9
A8
A7
A6
7Z77266

GXB10415	1024 x 1/OE	Fch 10415, Mot 10146/10415


A0
A1
A2
A3
A4
A5
DOUT
WE
GND
1
2
3
4
5
6
7
8
9
18
17
16
15
14
13
12
11
10
VCC
A11
A10
A9
A8
A7
A6
DIN
CE
7Z77278

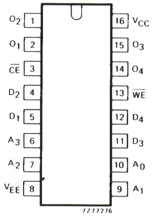
82S400	4096 x 1/OC	TI 2708
82S401	4096 x 1/TS	TI 2708

memories

pin diagrams — second sources

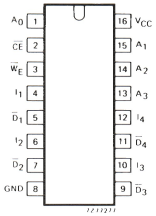
Bipolar

RAMs 4 bits wide



O_2 1
O_1 2
$\overline{CE}$ 3
D_2 4
D_1 5
A_3 6
A_2 7
V_{EE} 8
16 V_{CC}
15 O_3
14 O_4
13 $\overline{WE}$
12 D_4
11 D_3
10 A_0
9 A_1
7Z77276

type	capacity/output structure	second source
GXB10145	16 x 4/OE	Fch 10145A, Mot 10145,

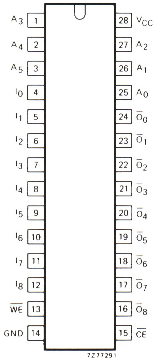


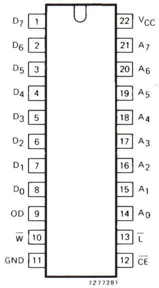
A_0 1
$\overline{CE}$ 2
W_E 3
I_1 4
$\overline{D}_1$ 5
I_2 6
$\overline{D}_2$ 7
GND 8
16 V_{CC}
15 A_1
14 A_2
13 A_3
12 I_4
11 $\overline{D}_4$
10 I_3
9 $\overline{D}_3$
7Z77277

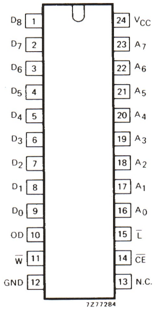
82S25	16 x 4/OC	AMD 3101, Fch 93403, Harris 0064, Intel 3101, Intersil 5501, MMI 6560, Mot 4064, National 86L99
74S89	16 x 4/OC	TI 74S89
74S189	16 x 4/TS	MMI 6561, TI 74S189
3101A	16 x 4/OC	AMD 3101A/27S02, Intel 3101A, MMI 6560, TI 74S289

RAMs 1 byte (8 or 9 bits) wide

type	capacity/output structure	second source
82S09	64 x 9/OC	Fch 93419, MMI 6555
82S208	256 x 8/TS	–
82S210	256 x 9/TS	–


A3 1
A4 2
A5 3
I0 4
I1 5
I2 6
I3 7
I4 8
I5 9
I6 10
I7 11
I8 12
WE 13
GND 14
28 VCC
27 A2
26 A1
25 A0
24 O0
23 O1
22 O2
21 O3
20 O4
19 O5
18 O6
17 O7
16 O8
15 CE
7Z77291


D7 1
D6 2
D5 3
D4 4
D3 5
D2 6
D1 7
D0 8
OD 9
W 10
GND 11
22 VCC
21 A7
20 A6
19 A5
18 A4
17 A3
16 A2
15 A1
14 A0
13 L
12 CE
7Z77281

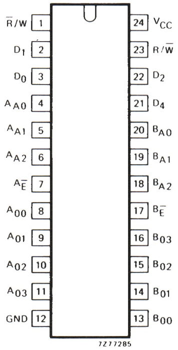

D8 1
D7 2
D6 3
D5 4
D4 5
D3 6
D2 7
D1 8
D0 9
OD 10
W 11
GND 12
24 VCC
23 A7
22 A6
21 A5
20 A4
19 A3
18 A2
17 A1
16 A0
15 L
14 CE
13 N.C.
7Z77284

memories

pin diagrams — second sources

Bipolar

Specials (SAM, WWRM, CAM)

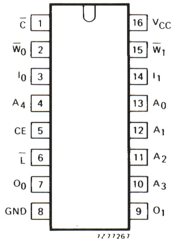


$\overline{R}$/W 1
D_1 2
D_0 3
A_{A0} 4
A_{A1} 5
A_{A2} 6
$A_{\overline{E}}$ 7
A_{00} 8
A_{01} 9
A_{02} 10
A_{03} 11
GND 12
24 V_{CC}
23 R/$\overline{W}$
22 D_2
21 D_4
20 B_{A0}
19 B_{A1}
18 B_{A2}
17 $B_{\overline{E}}$
16 B_{03}
15 B_{02}
14 B_{01}
13 B_{00}
7Z77285

type	capacity/output structure	second source
82S12	8 x 4 SAM/OC	–
82S112	8 x 4 SAM/TS	–

A **S**imultaneous **A**ddressable **M**emory or multiport memory is one in which different locations can be selected at the same time.

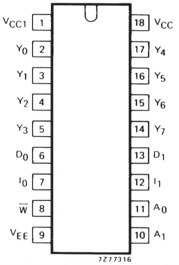
The 82S12/112 SAM-element has two independent sets of address-decoders and outputs.



$\overline{C}$ 1
$\overline{W}_0$ 2
I_0 3
A_4 4
CE 5
$\overline{L}$ 6
O_0 7
GND 8
16 V_{CC}
15 $\overline{W}_1$
14 I_1
13 A_0
12 A_1
11 A_2
10 A_3
9 O_1
7Z77267

82S21	32 x 2 WWRM/OC	–

A **W**rite **W**hile **R**ead **M**emory element is a RAM provided with output latches, in such a way that (read out) data may be retained in the latches either when the chip is disabled or when new information has to be written in the memory.



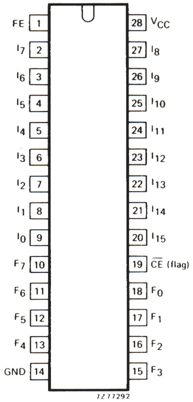
V_{CC1} 1
Y_0 2
Y_1 3
Y_2 4
Y_3 5
D_0 6
I_0 7
$\overline{W}$ 8
V_{EE} 9
18 V_{CC}
17 Y_4
16 Y_5
15 Y_6
14 Y_7
13 D_1
12 I_1
11 A_0
10 A_1
7Z77316

GXB10155	8 x 2 CAM/OE	–

In a **C**ontent **A**ddressable **M**emory or association memory the address information is associated with the memory content to search whether and/or in which location this information is stored; data is searched in parallel.

The normal functions of read-out and write-in can also be performed.

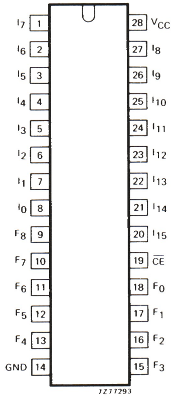
Specials (PLA, FPLA, FPGA)


FE 1
I7 2
I6 3
I5 4
I4 5
I3 6
I2 7
I1 8
I0 9
F7 10
F6 11
F5 12
F4 13
GND 14
28 VCC
27 I8
26 I9
25 I10
24 I11
23 I12
22 I13
21 I14
20 I15
19 CE (flag)
18 F0
17 F1
16 F2
15 F3
7Z77292

type	capacity/output structure	second source
82S100	16 x 48 x 8 FPLA/TS	AMD 2981, MMI 82S100
82S101	16 x 48 x 8 FPLA/OC	AMD 2980, MMI 82S101
82S200	16 x 48 x 8 PLA/TS	–
82S201	16 x 48 x 8 PLA/OC	–
82S106	16 x 48 x 8 FPLA/OC	–
82S107	16 x 48 x 8 FPLA/TS	–

In the 82S106/107, the chip enable input is replaced by a "flag" output indicating whether a programmed product term is activated.

The Programmable Logic Array is a two level AND-OR/AND-NOR combinational logic element, consisting of a system of logic gates with programmable inputs and outputs in order to generate series of product-terms according to customer requirements. Programming can either be done during production (PLA) or by the customer in the field (FPLA).


I7 1
I6 2
I5 3
I4 4
I3 5
I2 6
I1 7
I0 8
F8 9
F7 10
F6 11
F5 12
F4 13
GND 14
28 VCC
27 I8
26 I9
25 I10
24 I11
23 I12
22 I13
21 I14
20 I15
19 CE
18 F0
17 F1
16 F2
15 F3
7Z77293

82S102	16 x 9 FPGA/OC	–
82S103	16 x 9 FPGA/TS	–

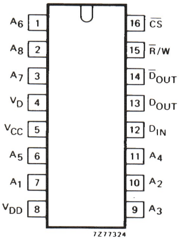
The Field Programmable Gate Array is a one-level AND/NAND logic element with programmable inputs and outputs to generate several AND/NAND functions according to customer requirements.

memories

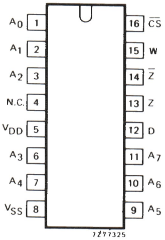
pin diagrams — second sources

MOS

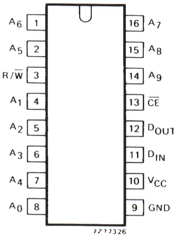
Static RAMs 1-bit wide


A6 1
A8 2
A7 3
VD 4
VCC 5
A5 6
A1 7
VDD 8
16 CS
15 R/W
14 DOUT
13 DOUT
12 DIN
11 A4
10 A2
9 A3
7Z77324

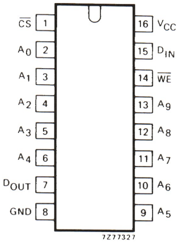
type	capacity	second source
2501	256 x 1	AMD P1101, Intel P1101, Intersil IM7501, Mostek MK4007, National MM1101
25L01	256 x 1	Mostek MK4007


A0 1
A1 2
A2 3
N.C. 4
VDD 5
A3 6
A4 7
VSS 8
16 CS
15 W
14 Z
13 Z
12 D
11 A7
10 A6
9 A5
7Z77325

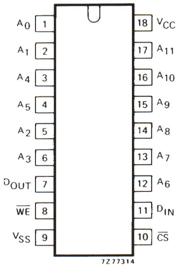
type	capacity	second source
HEF4720B(V)	256 x 1	Fch F4720


A6 1
A5 2
R/W 3
A1 4
A2 5
A3 6
A4 7
A0 8
16 A7
15 A8
14 A9
13 CE
12 DOUT
11 DIN
10 VCC
9 GND
7Z77326

type	capacity	second source
2102 **21F02** **21L02**	1024 x 1 1024 x 1 1024 x 1	AMD 2102, Fch 2102, Intel 2102A, Intersil IM7552, Mostek MK4102, National MM2102, TI TMS4035
2102A	1024 x 1	Intel 2102A
2102AL	1024 x 1	Intel 2102AL


$\overline{CS}$ 1
A_0 2
A_1 3
A_2 4
A_3 5
A_4 6
D_{OUT} 7
GND 8
16 V_{CC}
15 D_{IN}
14 $\overline{WE}$
13 A_9
12 A_8
11 A_7
10 A_6
9 A_5
7Z77327

type	capacity	second source
2115	1024 x 1	Intel 2115
2125	1024 x 1	Intel 2125


A_0 1
A_1 2
A_4 3
A_5 4
A_2 5
A_3 6
D_{OUT} 7
$\overline{WE}$ 8
V_{SS} 9
18 V_{CC}
17 A_{11}
16 A_{10}
15 A_9
14 A_8
13 A_7
12 A_6
11 D_{IN}
10 $\overline{CS}$
7Z77314

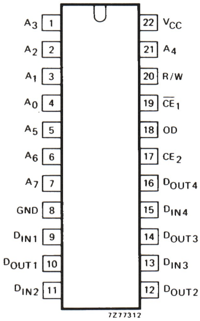
2613	4096 x 1	Intel
2623	4096 x 1	Intel

memories

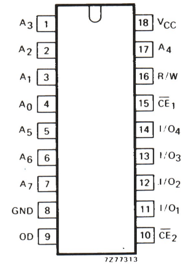
pin diagrams — second sources

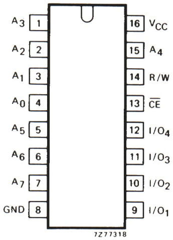
MOS

Static RAMs 4-bits wide

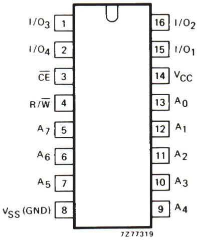

A3 1
A2 2
A1 3
A0 4
A5 5
A6 6
A7 7
GND 8
DIN1 9
DOUT1 10
DIN2 11
22 VCC
21 A4
20 R/W
19 CE1
18 OD
17 CE2
16 DOUT4
15 DIN4
14 DOUT3
13 DIN3
12 DOUT2
7Z77312

type	capacity	second source
2101	256 x 4	Intel 2101
2111	256 x 4	Intel 2111

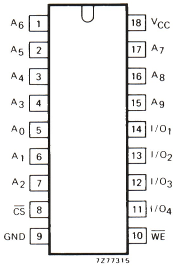

A3 1
A2 2
A1 3
A0 4
A5 5
A6 6
A7 7
GND 8
OD 9
18 VCC
17 A4
16 R/W
15 CE1
14 I/O4
13 I/O3
12 I/O2
11 I/O1
10 CE2
7Z77313


A3 1
A2 2
A1 3
A0 4
A5 5
A6 6
A7 7
GND 8
16 VCC
15 A4
14 R/W
13 CE
12 I/O4
11 I/O3
10 I/O2
9 I/O1
7Z77318

type	capacity	second source
2112	256 x 4	Intel 2112


I/O3 1
I/O4 2
CE 3
R/W 4
A7 5
A6 6
A5 7
VSS (GND) 8
16 I/O2
15 I/O1
14 VCC
13 A0
12 A1
11 A2
10 A3
9 A4
7Z77319

2606	256 x 4	–
2606-1	256 x 4	–


A6 1
A5 2
A4 3
A3 4
A0 5
A1 6
A2 7
CS 8
GND 9
18 VCC
17 A7
16 A8
15 A9
14 I/O1
13 I/O2
12 I/O3
11 I/O4
10 WE
7Z77315

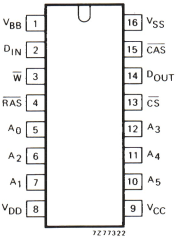
2614	1024 x 4	Intel 2114
2624	1024 x 4	Intel

memories

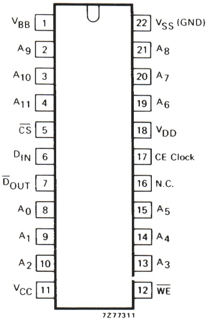
pin diagrams — second sources

MOS

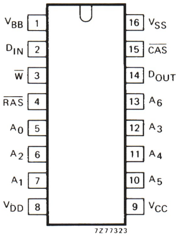
Dynamic RAMs 1-bit wide



V_{BB} 1
D_{IN} 2
$\overline{W}$ 3
$\overline{RAS}$ 4
A_0 5
A_2 6
A_1 7
V_{DD} 8
16 V_{SS}
15 $\overline{CAS}$
14 D_{OUT}
13 $\overline{CS}$
12 A_3
11 A_4
10 A_5
9 V_{CC}
7Z77322



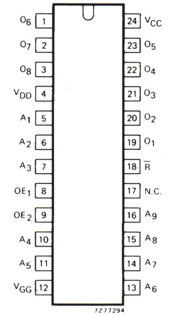
V_{BB} 1
A_9 2
A_{10} 3
A_{11} 4
$\overline{CS}$ 5
D_{IN} 6
$\overline{D}_{OUT}$ 7
A_0 8
A_1 9
A_2 10
V_{CC} 11
22 V_{SS} (GND)
21 A_8
20 A_7
19 A_6
18 V_{DD}
17 CE Clock
16 N.C.
15 A_5
14 A_4
13 A_3
12 $\overline{WE}$
7Z77311

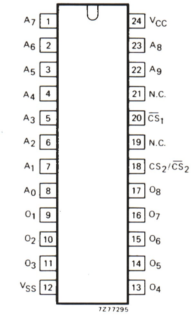


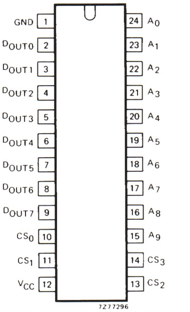
V_{BB} 1
D_{IN} 2
$\overline{W}$ 3
$\overline{RAS}$ 4
A_0 5
A_2 6
A_1 7
V_{DD} 8
16 V_{SS}
15 $\overline{CAS}$
14 D_{OUT}
13 A_6
12 A_3
11 A_4
10 A_5
9 V_{CC}
7Z77323

type	capacity	second source
2627	4096 x 1	Mostek MK4027
2660	4096 x 1	Mostek MK4096
2680	4096 x 1	AMD 9060, Intel 2107B, National MM5280, TI TMS4060, TMS4030
2690	16384 x 1	Intel 2116A, Mostek MK4116

ROMs 8-bits wide


O_6 1
O_7 2
O_8 3
V_{DD} 4
A_1 5
A_2 6
A_3 7
OE_1 8
OE_2 9
A_4 10
A_5 11
V_{GG} 12
24 V_{CC}
23 O_5
22 O_4
21 O_3
20 O_2
19 O_1
18 $\overline{R}$
17 N.C.
16 A_9
15 A_8
14 A_7
13 A_6
7Z77294


A_7 1
A_6 2
A_5 3
A_4 4
A_3 5
A_2 6
A_1 7
A_0 8
O_1 9
O_2 10
O_3 11
V_{SS} 12
24 V_{CC}
23 A_8
22 A_9
21 N.C.
20 $\overline{CS}_1$
19 N.C.
18 $CS_2/\overline{CS}_2$
17 O_8
16 O_7
15 O_6
14 O_5
13 O_4
7Z77295


GND 1
D_{OUT0} 2
D_{OUT1} 3
D_{OUT2} 4
D_{OUT3} 5
D_{OUT4} 6
D_{OUT5} 7
D_{OUT6} 8
D_{OUT7} 9
CS_0 10
CS_1 11
V_{CC} 12
24 A_0
23 A_1
22 A_2
21 A_3
20 A_4
19 A_5
18 A_6
17 A_7
16 A_8
15 A_9
14 CS_3
13 CS_2
7Z77296

type	capacity	second source
2530	512 x 8	General 2530
2607	1024 x 8	Intel 2308, EPROM – Intel 2708
2608	1024 x 8	Motorola 6830

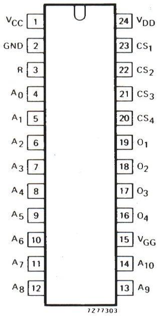
memories

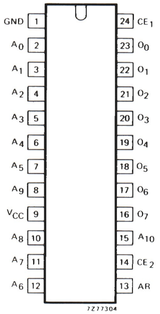
pin diagrams — second sources

MOS

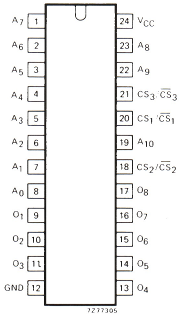
ROMs 4 and 8-bits wide

type	capacity	second source
2580	2048 x 4	General 2580
2600	2048 x 8	Electronic Arrays 4600 and 4900, Mostek 29000, Synertex 4600

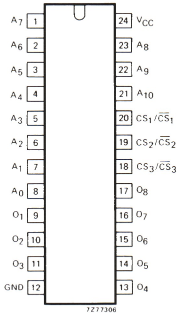

VCC 1
GND 2
R 3
A0 4
A1 5
A2 6
A3 7
A4 8
A5 9
A6 10
A7 11
A8 12
24 VDD
23 CS1
22 CS2
21 CS3
20 CS4
19 O1
18 O2
17 O3
16 O4
15 VGG
14 A10
13 A9
7Z77303


GND 1
A0 2
A1 3
A2 4
A3 5
A4 6
A5 7
A9 8
VCC 9
A8 10
A7 11
A6 12
24 CE1
23 O0
22 O1
21 O2
20 O3
19 O4
18 O5
17 O6
16 O7
15 A10
14 CE2
13 AR
7Z77304

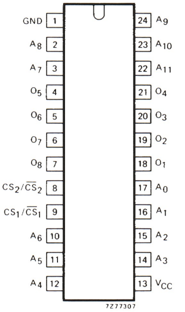
type	capacity	second source
2616	2048 x 8	Intel 2316E, Synertex 2316B
2617	2048 x 8	AMD 9216
2632	4096 x 8	–



A_7 1
A_6 2
A_5 3
A_4 4
A_3 5
A_2 6
A_1 7
A_0 8
O_1 9
O_2 10
O_3 11
GND 12
24 V_{CC}
23 A_8
22 A_9
21 $CS_3/\overline{CS_3}$
20 $CS_1/\overline{CS_1}$
19 A_{10}
18 $CS_2/\overline{CS_2}$
17 O_8
16 O_7
15 O_6
14 O_5
13 O_4
7Z77305



A_7 1
A_6 2
A_5 3
A_4 4
A_3 5
A_2 6
A_1 7
A_0 8
O_1 9
O_2 10
O_3 11
GND 12
24 V_{CC}
23 A_8
22 A_9
21 A_{10}
20 $CS_1/\overline{CS_1}$
19 $CS_2/\overline{CS_2}$
18 $CS_3/\overline{CS_3}$
17 O_8
16 O_7
15 O_6
14 O_5
13 O_4
7Z77306

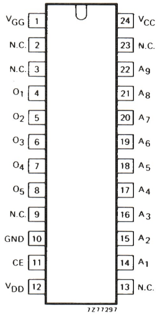


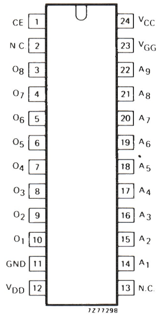
GND 1
A_8 2
A_7 3
O_5 4
O_6 5
O_7 6
O_8 7
$CS_2/\overline{CS_2}$ 8
$CS_1/\overline{CS_1}$ 9
A_6 10
A_5 11
A_4 12
24 A_9
23 A_{10}
22 A_{11}
21 O_4
20 O_3
19 O_2
18 O_1
17 A_0
16 A_1
15 A_2
14 A_3
13 V_{CC}
7Z77307

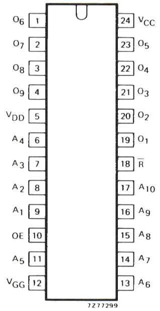
pin diagrams — second sources

MOS

Character generators


VGG 1
N.C. 2
N.C. 3
O1 4
O2 5
O3 6
O4 7
O5 8
N.C. 9
GND 10
CE 11
VDD 12
24 VCC
23 N.C.
22 A9
21 A8
20 A7
19 A6
18 A5
17 A4
16 A3
15 A2
14 A1
13 N.C.
7Z77297

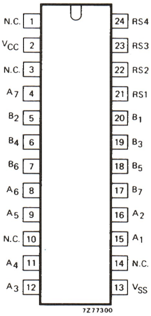

CE 1
N.C. 2
O8 3
O7 4
O6 5
O5 6
O4 7
O3 8
O2 9
O1 10
GND 11
VDD 12
24 VCC
23 VGG
22 A9
21 A8
20 A7
19 A6
18 A5
17 A4
16 A3
15 A2
14 A1
13 N.C.
7Z77298

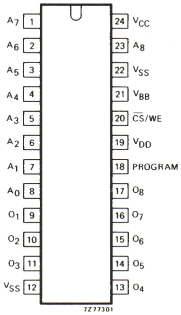

O6 1
O7 2
O8 3
O9 4
VDD 5
A4 6
A3 7
A2 8
A1 9
OE 10
A5 11
VGG 12
24 VCC
23 O5
22 O4
21 O3
20 O2
19 O1
18 R̄
17 A10
16 A9
15 A8
14 A7
13 A6
7Z77299

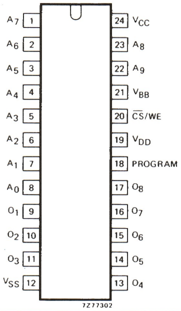
type	capacity	second source
2513	64 x 8 x 5	General 2513
2516	64 x 6 x 8	General 2516
2526	64 x 9 x 9	–

EPROMs

type	capacity	second source
2609	128 x 7 x 9	Motorola 6570
2704	4096	Intel 2704
2708	8192	Intel 2708


N.C. 1
V_{CC} 2
N.C. 3
A_7 4
B_2 5
B_4 6
B_6 7
A_6 8
A_5 9
N.C. 10
A_4 11
A_3 12
24 RS4
23 RS3
22 RS2
21 RS1
20 B_1
19 B_3
18 B_5
17 B_7
16 A_2
15 A_1
14 N.C.
13 V_{SS}
7Z77300


A_7 1
A_6 2
A_5 3
A_4 4
A_3 5
A_2 6
A_1 7
A_0 8
O_1 9
O_2 10
O_3 11
V_{SS} 12
24 V_{CC}
23 A_8
22 V_{SS}
21 V_{BB}
20 $\overline{CS}$/WE
19 V_{DD}
18 PROGRAM
17 O_8
16 O_7
15 O_6
14 O_5
13 O_4
7Z77301

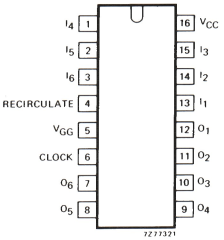

A_7 1
A_6 2
A_5 3
A_4 4
A_3 5
A_2 6
A_1 7
A_0 8
O_1 9
O_2 10
O_3 11
V_{SS} 12
24 V_{CC}
23 A_8
22 A_9
21 V_{BB}
20 $\overline{CS}$/WE
19 V_{DD}
18 PROGRAM
17 O_8
16 O_7
15 O_6
14 O_5
13 O_4
7Z77302

memories

pin diagrams — second sources

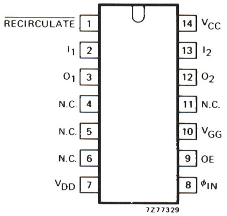
MOS

Static shift registers



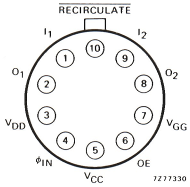
I_4 1
I_5 2
I_6 3
RECIRCULATE 4
V_{GG} 5
CLOCK 6
O_6 7
O_5 8
16 V_{CC}
15 I_3
14 I_2
13 I_1
12 O_1
11 O_2
10 O_3
9 O_4
7Z77321

type	capacity	second source
2518	6 x 32	Fch 3349, TI TMS3112NC
2519	6 x 40	–

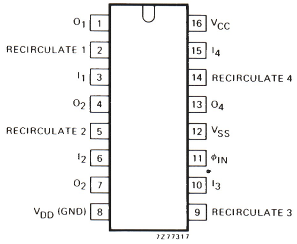


$\overline{\text{RECIRCULATE}}$ 1
I_1 2
O_1 3
N.C. 4
N.C. 5
N.C. 6
V_{DD} 7
14 V_{CC}
13 I_2
12 O_2
11 N.C.
10 V_{GG}
9 OE
8 ϕ_{IN}
7Z77329

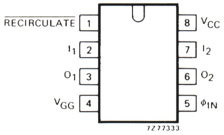
2509	2 x 50	General 2509
2510	2 x 100	General 2510
2511	2 x 200	General 2511



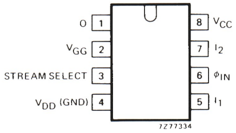
$\overline{\text{RECIRCULATE}}$
I_1
I_2
O_1
O_2
V_{DD}
V_{GG}
ϕ_{IN}
OE
V_{CC}
1
2
3
4
5
6
7
8
9
10
7Z77330


O1
1
RECIRCULATE 1
2
I1
3
O2
4
RECIRCULATE 2
5
I2
6
O2
7
VDD (GND)
8
16
VCC
15
I4
14
RECIRCULATE 4
13
O4
12
VSS
11
ϕIN
10
I3
9
RECIRCULATE 3
7Z77317

type	capacity	second source
2532	4 x 80	Fch 3347, Intersil IM7780C Mostek MK1007P, TI TMS3120NC


RECIRCULATE
1
I1
2
O1
3
VGG
4
8
VCC
7
I2
6
O2
5
ϕIN
7Z77333

2521	2 x 128	AMD AM2809, Fch 3343, National MM2521, TI TMS3128NC
2522	2 x 132	Fch 3344, National MM2522, TI TMS3129NC
2529	2 x 240	–
2528	2 x 250	–
2527	2 x 256	–


O
1
VGG
2
STREAM SELECT
3
VDD (GND)
4
8
VCC
7
I2
6
ϕIN
5
I1
7Z77334

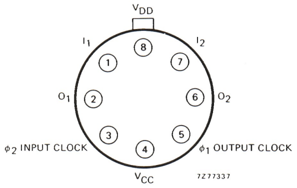
2533	1024	AMD AM2833PC, Fch 3533, General 2533, National MM5058, TI TMS3133NC

memories

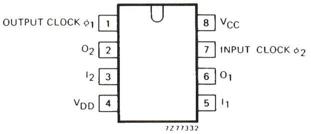
pin diagrams — second sources

MOS

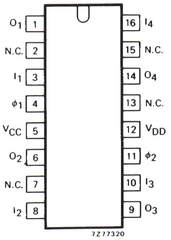
Dynamic shift registers



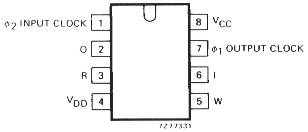
VDD
I1
I2
O1
O2
φ2 INPUT CLOCK
φ1 OUTPUT CLOCK
VCC
1
2
3
4
5
6
7
8
7Z77337



OUTPUT CLOCK φ1 1
O2 2
I2 3
VDD 4
8 VCC
7 INPUT CLOCK φ2
6 O1
5 I1
7Z77332

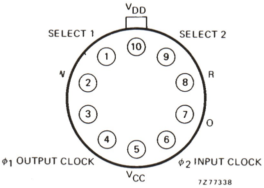


O1 1
N.C. 2
I1 3
φ1 4
VCC 5
O2 6
N.C. 7
I2 8
16 I4
15 N.C.
14 O4
13 N.C.
12 VDD
11 φ2
10 I3
9 O3
7Z77320

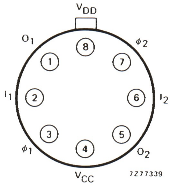


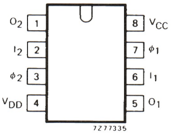
φ2 INPUT CLOCK 1
O 2
R 3
VDD 4
8 VCC
7 φ1 OUTPUT CLOCK
6 I
5 W
7Z77331

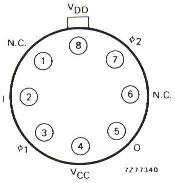
type	capacity	second source
2506	2 x 100	AMD AM1507T, National MM1506H
2507	2 x 100	—
2517	2 x 100	AMD AM1507, National MM1507H
2502	4 x 256	AMD AM1402APC, Intel C1402A, National MM1402A
2524	512	AMD AM2807PC
2525	1024	AMD AM2808PC, Intersil IM7722C

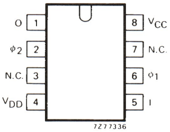

VDD
SELECT 1
SELECT 2
N
R
O
ϕ1 OUTPUT CLOCK
ϕ2 INPUT CLOCK
VCC
1
2
3
4
5
6
7
8
9
10
7Z77338

type	capacity	second source
2505	512	AMD AM2505K, Intel M1405A
2512	1024	AMD AM2806HC, Intersil IM7712C
2503	2 x 512	AMD AM1403A, Intel C1403A, National MM1403A
2504	1024	AMD AM1404A, Intel M1404A, National MM1404A


VDD
O1
ϕ2
I1
I2
ϕ1
O2
VCC
1
2
3
4
5
6
7
8
7Z77339


O2
I2
ϕ2
VDD
VCC
ϕ1
I1
O1
1
2
3
4
5
6
7
8
7Z77335


VDD
N.C.
ϕ2
I
N.C.
ϕ1
O
VCC
1
2
3
4
5
6
7
8
7Z77340


O
ϕ2
N.C.
VDD
VCC
N.C.
ϕ1
I
1
2
3
4
5
6
7
8
7Z77336

microprocessors

type index

cross reference

Bipolar		MOS	
AMD	**Signetics**	**National**	**Signetics**
2901A	N2901-1	2650	2650
Intel	**Signetics**		
3001	N3001		
3002	N3002		

Type index

technology	description	type	page
Bipolar	Cyclic Redundancy Check generator/checker	**8X01**	B170
	Control Store Sequencer	**8X02**	B171
	Microprocessor	**8X300**	B167
	Designers evaluation kit	**8X300KT100SK**	B168-B169
	Synchronous Input/Output Port – three-state	**N8T32**	B172
	Synchronous I/O Port – open collector	**N8T33**	B172
	Asynchronous I/O Port – open collector	**N8T35**	B172
	Asynchronous I/O Port – three-state	**N8T36**	B172
	Interface Vector Byte address programming kit	**8T32KT1000SK**	B173
	Bus Expander	**N8T39**	B174
	Microprocessor Central Processing Element	**N2901-1**	B175
	Microprogram Control Unit	**N3001**	B176
	Central Processing Element	**N3002**	B177
	Prototyping kit	**3000KT1000**	B177
	Emulator kit	**3000KT8080SK**	B178-B179
MOS	8-bit Microprocessor	**2650**	B180-B185
	8-bit Microprocessor	**2650A**	B180-B185
	Programmable Communications Interface (PCI)	**2651**	B186-B189
	Multi Protocol Communications Controller (MPCC)	**2652**	B190-B192
	Programmable Peripheral Interface (PPI)	**2655**	B193-B195
	System Memory Interface (SMI)	**2656**	B196-B199
	Emulator Board for 2656	**2650PC4000**	B200-B202
	Microprocessor Prototyping Card	**2650PC1001**	B203-B205
	Adaptable Board Computer (ABC) assembled	**2650PC1500**	B206-B210
	Adaptable Board Computer (ABC) kit	**2650KT9500**	B206-B210
	Resident Assembler Board	**2650PC1600**	B211
	4k Memory Card	**2650PC2000**	B212-B213
	Microprocessor Demonstration System	**2650DS2000**	B214-B216
	Intelligent Typewriter Controller	**2650PC3000**	B217-B220
	Microprocessor Prototyping Kit	**2650KT9100**	B221-B222
	2650 Assembler version 3.2	**2650AS1000/1100**	B223-B224
	2650 Simulator version 1.2	**2650SM1000/1100**	B225-B226
	Signetics Higher Level Language (PLμS)	**2650PL1000**	B227
	Microcomputer Prototype Development System	**TWIN**	B228-B230

8X300 fixed instruction set bipolar microprocessor

The Signetics 8X300 is a monolithic, high-speed microprocessor implemented with bipolar Schottky technology. As the central processing unit, CPU, it allows 16-bit instructions to be fetched, decoded and executed in 250 ns. A 250 ns instruction cycle requires maximum memory access of 65 ns, and maximum I/O device access of 35 ns.

Instructions operate on an 8-bit byte. Input data can be rotated and masked before being subjected to an arithmetic or logic operation. Output data can be shifted and merged with the input data before being applied to external logic. This allows 1 to 8-bit I/O and data memory fields to be accessed and the resulting data to be processed in a single instruction cycle.

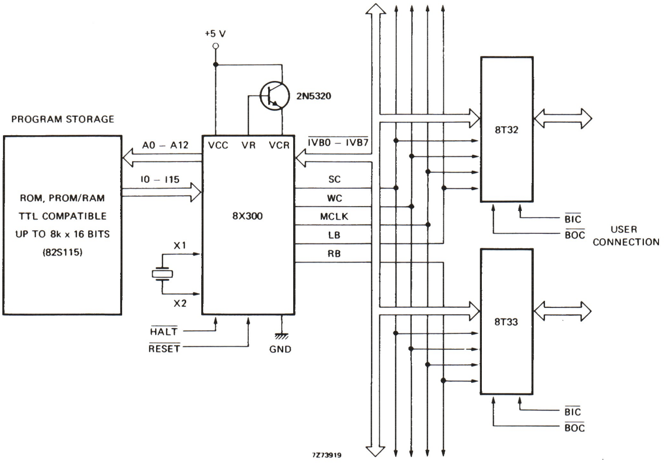
Features

- 185 ns instruction decode and execute delay (with Signetics 8T32/33 I/O port)
- Eight 8-bit working registers
- Single instruction access to 1-bit, 2-bit, 3-bit ... or 8-bit field on I/O bus
- Separate instruction address, instruction, and I/O data busses
- On-chip oscillator
- Bipolar Schottky technology
- TTL inputs and outputs
- Three-state output on I/O data bus
- +5 V operation from 0 to 70 °C

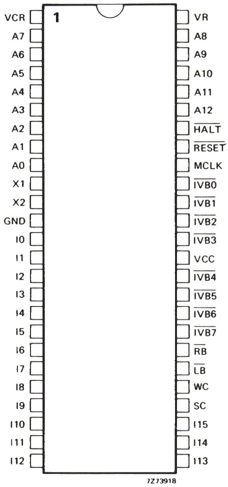
8X300 Instruction Set

- General purpose instruction set with substantial capabilities in arithmetic, byte and bit manipulation and I/O processing
- 16-bit instruction word
- 13 bits allow 8k program words
- Eight instruction classes: MOVE, ADD, AND, XOR, XEC, NZT, XMIT and JMP

Typical system configuration


+5 V
2N5320
PROGRAM STORAGE
ROM, PROM/RAM
TTL COMPATIBLE
UP TO 8k x 16 BITS
(82S115)
A0 – A12
I0 – I15
X1
X2
VCC
VR
VCR
8X300
IVB0 – IVB7
SC
WC
MCLK
LB
RB
HALT
RESET
GND
8T32
8T33
BIC
BOC
USER CONNECTION
BIC
BOC
7Z73919

Pin configuration – I package


1
VCR
A7
A6
A5
A4
A3
A2
A1
A0
X1
X2
GND
I0
I1
I2
I3
I4
I5
I6
I7
I8
I9
I10
I11
I12
VR
A8
A9
A10
A11
A12
HALT
RESET
MCLK
IVB0
IVB1
IVB2
IVB3
VCC
IVB4
IVB5
IVB6
IVB7
RB
LB
WC
SC
I15
I14
I13
7Z73918

8X300KT100SK designer's evaluation kit for fixed instruction bipolar microprocessor

The Signetics 8X300 Fixed Instruction Bipolar Microprocessor provides new levels of high performance to microprocessor applications not previously possible with MOS technology.

In the majority of cases, the choice of a bipolar microprocessor slice, as opposed to a MOS device, is based on speed. The 8X300 processor, combined with high-speed memory and I/O devices, is capable of executing all instructions in 250 ns.

The 8X300 is optimized for control and data movement applications. It has a 13-bit address bus for selecting instructions from program storage and a separate input bus for entering 16-bit instruction words. Data handling and I/O device addressing are accomplished via the 8-bit Interface Vector (IV) bus. The IV bus is supported by four additional control lines and a clock.

The unique features of the 8X300 IV bus and instruction set permit 8-bit parallel data to be rotated or masked before undergoing arithmetic or logic operations. Then, the data may be shifted and merged into any set of from 1 to 8 contiguous bits at the destination. The entire process of input, shifting, processing and output is done in 1 instruction cycle time. The 250 ns cycle time makes the 8X300 ideally suited for high-speed applications.

The evaluation board contains all the elements which a designer needs to judge the suitability of the 8X300 for his systems applications. Included with the 8X300 are 4 I/O ports for external device interface, 256 bytes of temporary (working) data storage, and 512 words of program storage, all properly connected to the 8X300 to allow immediate exercising of the board. For this purpose, the PROMs are preprogrammed with the I/O control, RAM control, and RAM integrity diagnostic programs. With the remaining PROM space, the designer may enter his own benchmark, test, or development routines.

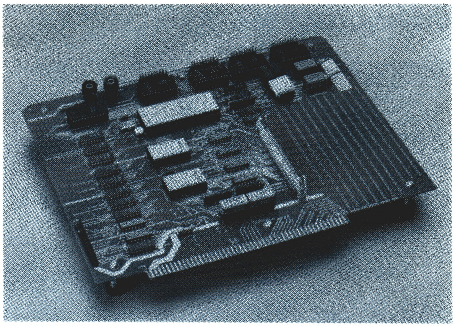
The board design allows complete flexibility in access to the address, instruction and IV busses as well as all controls and signals of the 8X300. The IV bus, I/O port user connection, clock signals control lines, address bus and instruction bus are wired to output pins, the board edge connector and flat cable connectors.

The board layout permits variations and/or expansions of the basic design. In addition to the access to all signals for transfer off the board, a wire wrap area is provided so that the designer may add to the board circuitry as he desires. The addition may include memory, additional interfaces, or special circuits which meet specific user requirements.

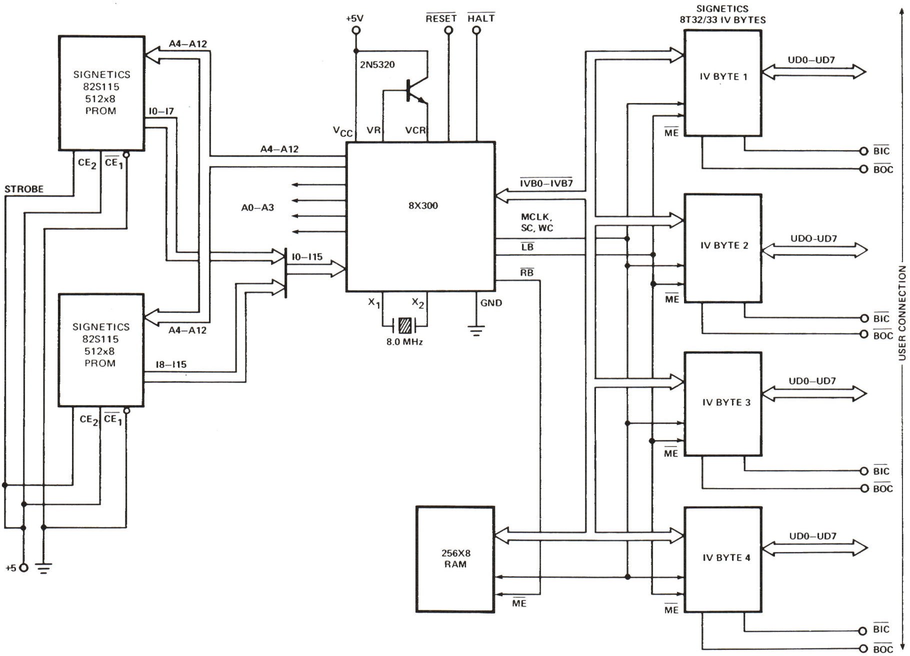
Controls are also provided for diagnostic and instructional purposes by allowing various operating modes. In the WAIT mode, the program may be single-stepped for ease of checkout. The one-shot instruction jamming allows control of the program start location, changes of program flow, changing or examining the internal registers, or testing of simple sequences. The repeated instruction jamming provides a means of repetitive execution of an instruction so that the I/O bus and the control lines may be examined without software changes. In both of these jam cases, the jammed instruction is selected by board-mounted switches.

Features

- 250 ns CPU with crystal
- 4 I/O ports (32 lines)
- 256 bytes data storage
- 512 words program storage
- run/wait control
- single step
- instruction jamming, one-shot instruction jam repeated jam
- all busses to output pins
- firmware diagnostics
- wire wrap area
- edge connector
- flat cable connectors
- wire wrap posts for bus lines



Assembled kit 8X300KT100SK


+5V
RESET
HALT
SIGNETICS
8T32/33 IV BYTES
SIGNETICS
82S115
512x8
PROM
A4–A12
I0–I7
2N5320
VCC
VR
VCR
A4–A12
CE2
CE1
STROBE
A0–A3
8X300
IVB0–IVB7
MCLK,
SC, WC
LB
RB
I0–I15
X1
X2
8.0 MHz
GND
SIGNETICS
82S115
512x8
PROM
A4–A12
I8–I15
CE2
CE1
+5
IV BYTE 1
UD0–UD7
ME
BIC
BOC
IV BYTE 2
UD0–UD7
ME
BIC
BOC
IV BYTE 3
UD0–UD7
ME
BIC
BOC
256X8
RAM
ME
IV BYTE 4
UD0–UD7
ME
BIC
BOC
USER CONNECTION

8X300 KIT CONFIGURATION

Contents

1 each	8X300
8 each	82S116 (256 x 1 RAM)
2 each	82S115 (512 x 8 PROM)
4 each	8T32 (addressable bidirectional I/O port)
1 each	8T31 (bidirectional I/O port)
2 each	8T26A (quad bus transceiver)
4 each	74157 (quad 2-input data selector)
2 each	7474 (dual D flip-flop)
2 each	7400 (quad NAND gate)
1 each	7427 (3-input NOR gate)
1 each	p.c. board
	miscellaneous parts
1 each	introductory manual, assembly instructions, code listings and schematics

microprocessors

technical data – **bipolar**

8X01 CRC generator/checker

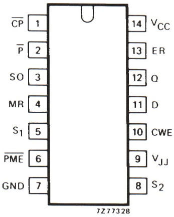
Objective specification

The CRC Generator/Checker circuit is used to provide an error detection capability for serial digital data handling system. The serial data stream is divided by a selected polynomial and the division remainder is transmitted at the end of the data stream as a Cyclic Redundancy Check Character (CRCC). When the data is received, the same calculation is performed. If the received message is error-free, the calculated remainder should satisfy a predetermined pattern. In most cases, the remainder is zero except in the case where Synchronous Data Link Control type protocols are used whereby the correct remainder is checked for 1111000010111000 ($X^0 - X^{15}$).

8 polynomials are provided and can be selected via a 3-bit control bus. Popular polynomials such as CRC-16 and CCITT are implemented. Polynomials can be programmed to start with either all zeros or all ones.

Automatic right justification for polynomials of degree less than 16 is provided.

Pin configuration – F, N packages



Features

- I^2L technology
- TTL inputs/outputs
- 5 MHz (max) data rate
- total power dissipation = 175 mW (max)
- V_{CC} = 5,0 V
- V_{JJ} = 1,0 V
- separate preset and reset controls
- SDLC specified pattern match
- automatic right justification

Typical applications

- floppy and other disc systems
- digital cassette and cartridge systems
- data communication systems

8X02 control store sequencer

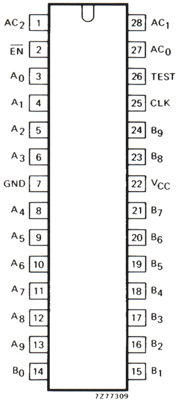
Objective specification

The Signetics 8X02 is a Low-Power Schottky LSI device intended for use in high performance microprogrammed systems to control the fetch sequence of microinstructions. When combined with standard ROM or PROM, the 8X02 forms a powerful microprogrammed control section for computers, controllers, or sequenced logic.

Features

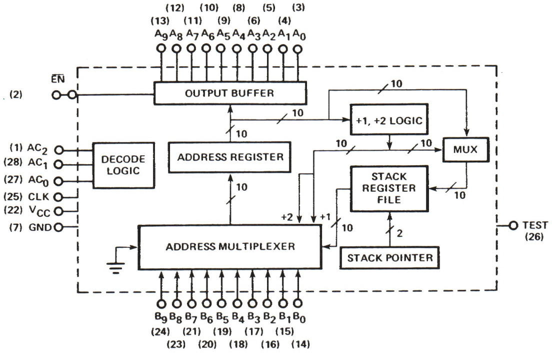
- low-power Schottky process
- 50 ns cycle time (typ)
- 1024 microinstruction addressability
- N-way branch
- 4-level stack register file (LIFO type)
- automatic push/pop stack operation
- "test & skip" operation on test input line
- 3-bit command code
- three-state buffered outputs
- auto-reset to address 0 during power up
- conditional branching, pop stack and push stack
- positive edge trigger (low-to-high transition)

Pin configuration — N, I packages



AC2 1
EN 2
A0 3
A1 4
A2 5
A3 6
GND 7
A4 8
A5 9
A6 10
A7 11
A8 12
A9 13
B0 14
28 AC1
27 AC0
26 TEST
25 CLK
24 B9
23 B8
22 VCC
21 B7
20 B6
19 B5
18 B4
17 B3
16 B2
15 B1
7Z77309

Block diagram



(12) (10) (8) (5) (3)
(13) (11) (9) (6) (4)
A9 A8 A7 A6 A5 A4 A3 A2 A1 A0
EN
(2)
OUTPUT BUFFER
10
+1, +2 LOGIC
10
10
ADDRESS REGISTER
10
10
MUX
(1) AC2
(28) AC1
(27) AC0
(25) CLK
(22) VCC
(7) GND
DECODE LOGIC
STACK REGISTER FILE
10
10
+2
+1
10
2
TEST (26)
ADDRESS MULTIPLEXER
STACK POINTER
B9 B8 B7 B6 B5 B4 B3 B2 B1 B0
(24) (21) (19) (17) (15)
(23) (20) (18) (16) (14)

8-bit latched addressable bidirectional I/O ports

8T32 Three-state, synchronous user port
8T33 Open collector, synchronous user port
8T35 Open collector, asynchronous user port
8T36 Three-state, asynchronous user port

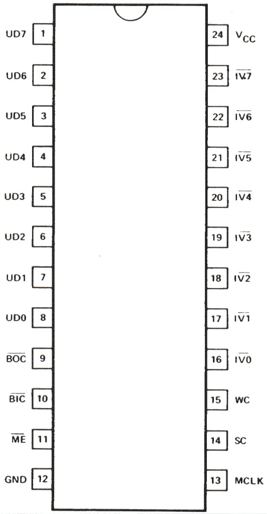
The interface vector (IV) byte is an 8-bit bidirectional data register designed to function as an I/O interface element in microprocessor systems. It contains 8 data latches accessible from either a microprocessor (IV) port or a user port. Separate I/O control is provided for each port. The 2 ports operate independently, except when both are attempting to input data into the IV byte. In this case, the user port has priority.

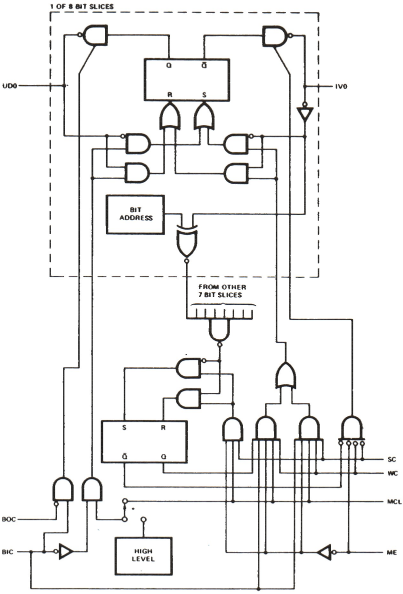
A unique feature of the 8T32/33/35/36 IV byte is the way in which it is addressed. Each IV byte has an 8-bit, field programmable address, which is used to enable the microprocessor port. When the SC control signal is HIGH, data at the microprocessor port is treated as an address. If the address matches the IV byte's internally programmed address, the microprocessor port is enabled, allowing data transfer through it.

Features

- A field-programmable address allows 1 of 512 IV bytes on a bus to be selected, without decoder
- Each byte has 2 ports, one to the user, the other to a microprocessor. IV bytes are completely bidirectional
- Ports are independent, with the user port having priority for data entry
- A selected IV byte de-selects itself when another IV byte address is sensed
- User data input available as synchronous (8T32, 8T33) or as asynchronous (8T35, 8T36) function
- The user data bus is available with three-state (8T32, 8T36) or open collector (8T33, 8T35) outputs
- At power up, the IV byte is not selected and the user port outputs are HIGH
- Three-state TTL outputs for high drive capability
- Directly compatible with the 8X300 interpreter
- Operates from a single 5 V power supply over a temperature range of 0 to 70 °C

F, N packages


UD7 1
UD6 2
UD5 3
UD4 4
UD3 5
UD2 6
UD1 7
UD0 8
BOC 9
BIC 10
ME 11
GND 12
24 VCC
23 IV7
22 IV6
21 IV5
20 IV4
19 IV3
18 IV2
17 IV1
16 IV0
15 WC
14 SC
13 MCLK


1 OF 8 BIT SLICES
UD0
IV0
Q
Q̄
R
S
BIT ADDRESS
FROM OTHER 7 BIT SLICES
S
R
Q̄
Q
SC
WC
MCLK
BOC
BIC
HIGH LEVEL
ME

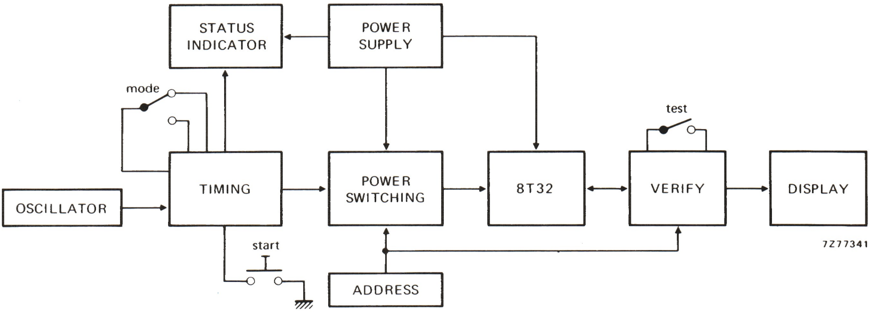
8T32KT1000SK programming kit for 8T32 addressable I/O port

This kit provides signals and levels required for programming the select addresses of the 8T32, 8T33, 8T35 and 8T36 I/O ports. Controls are provided for programming, testing and isolating the nichrome fuses which determine the device address.

Contents

1 x NE556A timer
2 x 74LS74 latch
1 x 74 LS93 counter
1 x 74LS154 decoder
4 x 8T26AB transceiver
2 x 74LS08 AND gate
1 x 8T80A NAND gate
1 x 74LS04 inverter
6 x 75450BA driver
2 x LM309DA regulator
printed circuit board and associated components

Block diagram


STATUS INDICATOR
POWER SUPPLY
mode
test
OSCILLATOR
TIMING
POWER SWITCHING
8T32
VERIFY
DISPLAY
start
ADDRESS
7Z77341

8T39 bus expander

The Bus Expander is specifically designed to increase the I/O capability of 8X300 systems previously limited by fan-out considerations. The bus expander serves as a buffer between the 8X300 and blocks of I/O devices. Each bus expander can buffer a block of 16 I/O ports while only adding a single load to the 8X300.

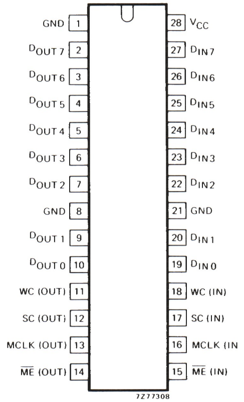
Features

- 15 ns propagation delay
- bidirectional
- three-state outputs on both ports
- pre programmed address range

Applications

The bus expander is not limited to use with the 8X300, but may be applied in any system which uses a combined address/data bus.

Pin configuration — I, N packages


GND 1
$D_{OUT\,7}$ 2
$D_{OUT\,6}$ 3
$D_{OUT\,5}$ 4
$D_{OUT\,4}$ 5
$D_{OUT\,3}$ 6
$D_{OUT\,2}$ 7
GND 8
$D_{OUT\,1}$ 9
$D_{OUT\,0}$ 10
WC (OUT) 11
SC (OUT) 12
MCLK (OUT) 13
$\overline{ME}$ (OUT) 14
28 V_{CC}
27 $D_{IN\,7}$
26 $D_{IN\,6}$
25 $D_{IN\,5}$
24 $D_{IN\,4}$
23 $D_{IN\,3}$
22 $D_{IN\,2}$
21 GND
20 $D_{IN\,1}$
19 $D_{IN\,0}$
18 WC (IN)
17 SC (IN)
16 MCLK (IN
15 $\overline{ME}$ (IN)
7Z77308

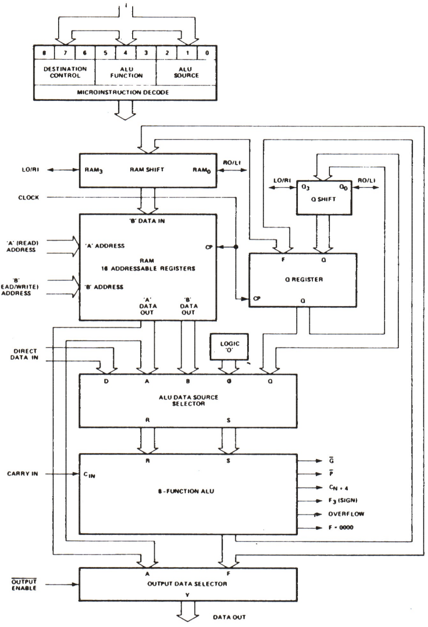
N2901-1 bipolar microprocessor processing element

Objective specification

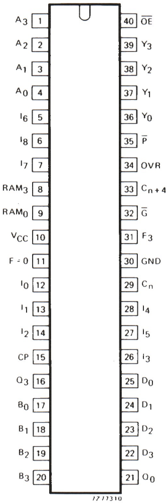
The 4-bit bipolar microprocessor slice is designed as a high-speed cascadable element intended for use in CPUs, peripheral controllers, programmable microprocessors and numerous other applications. The microinstruction flexibility of the 2901-1 will allow efficient emulation of almost any digital computing machine.

The device, as shown in the block diagram below, consists of a 16-word by 4-bit 2-port RAM, a high-speed ALU, and the associated shifting, decoding and multiplexing circuitry. The 9-bit microinstruction word is organized into 3 groups of 3 bits each and selects the ALU source operands, the ALU function, and the ALU destination register. The microprocessor is cascadable with full look-ahead or with ripple carry, has three-state outputs, and provides various status flag outputs from the ALU. Advanced low-power Schottky processing is used to fabricate this 40-lead LSI chip.

Block diagram


I
8 7 6 5 4 3 2 1 0
DESTINATION CONTROL
ALU FUNCTION
ALU SOURCE
MICROINSTRUCTION DECODE
LO/RI
RAM3
RAM SHIFT
RAM0
RO/LI
CLOCK
'B' DATA IN
'A' (READ) ADDRESS
'A' ADDRESS
CP
RAM
16 ADDRESSABLE REGISTERS
'B' (READ/WRITE) ADDRESS
'B' ADDRESS
'A' DATA OUT
'B' DATA OUT
LO/RI
Q3
Q0
RO/LI
Q SHIFT
F
Q
Q REGISTER
CP
Q
DIRECT DATA IN
LOGIC '0'
D
A
B
0
Q
ALU DATA SOURCE SELECTOR
R
S
CARRY IN
CIN
8-FUNCTION ALU
G
P
CN+4
F3 (SIGN)
OVERFLOW
F = 0000
OUTPUT ENABLE
A
F
OUTPUT DATA SELECTOR
Y
DATA OUT

Pin configuration — I, N packages


A3 1
A2 2
A1 3
A0 4
I6 5
I8 6
I7 7
RAM3 8
RAM0 9
VCC 10
F = 0 11
I0 12
I1 13
I2 14
CP 15
Q3 16
B0 17
B1 18
B2 19
B3 20
40 OE
39 Y3
38 Y2
37 Y1
36 Y0
35 P
34 OVR
33 Cn+4
32 G
31 F3
30 GND
29 Cn
28 I4
27 I5
26 I3
25 D0
24 D1
23 D2
22 D3
21 Q0
1717310

Features

- 80 ns cycle time
- 2-address architecture
  independent simultaneous access to 2 working registers saves machine cycles
- 8-function ALU
  performs addition, 2 subtraction operations, and 5 logic functions on 2 source operands
- flexible data source selection
  ALU data is selected from 5 source ports for a total of 203 source operand pairs for every ALU function
- left/right shift independent of ALU
  add and shift operations take only 1 cycle
- 4 status flags
  carry, overflow, zero, and negative
- expandable
  connect any number of 2901-1s together for longer word lengths
- microprogrammable
  3 groups of 3 bits each for source operand, ALU function, and destination control

Microprogram control unit N3001

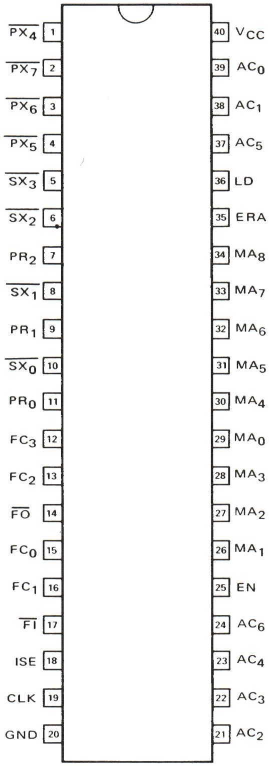
The N3001 MCU is one element of a bipolar microcomputer set. When used with the 3002, 74S182, ROM or PROM, a powerful microprogrammed computer can be implemented. The 3001 MCU controls the fetch sequence of microinstructions from the microprogram memory. Functions performed by the 3001 include:

- maintenance of microprogram address register
- selection of next microinstruction address
- decoding and testing of data supplied via several input busses
- saving and testing of carry output data from the central processing (CP) array
- control of carry/shift input data to the CP array
- control of microprogram interrupts

Features

- Schottky TTL process
- 45 ns cycle time (typ)
- direct addressing of standard bipolar PROM or ROM
- 512 microinstruction addressability
- advanced organization:
  9-bit microprogram address register and bus organized to address memory by row and column
  4-bit program latch
  2 flag registers
- 11 address control functions
- flight flag control functions:
  4 flag input functions
  4 flag output functions

Pin configuration — I, N packages


$\overline{PX_4}$ 1
$\overline{PX_7}$ 2
$\overline{PX_6}$ 3
$\overline{PX_5}$ 4
$\overline{SX_3}$ 5
$\overline{SX_2}$ 6
PR_2 7
$\overline{SX_1}$ 8
PR_1 9
$\overline{SX_0}$ 10
PR_0 11
FC_3 12
FC_2 13
$\overline{FO}$ 14
FC_0 15
FC_1 16
$\overline{FI}$ 17
ISE 18
CLK 19
GND 20
40 V_{CC}
39 AC_0
38 AC_1
37 AC_5
36 LD
35 ERA
34 MA_8
33 MA_7
32 MA_6
31 MA_5
30 MA_4
29 MA_0
28 MA_3
27 MA_2
26 MA_1
25 EN
24 AC_6
23 AC_4
22 AC_3
21 AC_2

Central processing element N3002

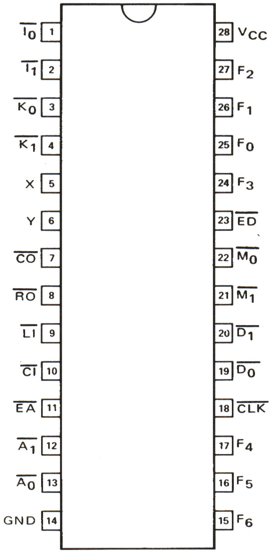
3000KT1000
prototyping kit.

The N3002 central processing element (CPE) is one part of a bipolar microcomputer set. The N3002 is organized as a 2-bit slice and performs the logical and arithmetic functions required by microinstructions. A system with any number of bits in a data word can be implemented by using multiple N3002s, the N3001 microcomputer control unit, the N74S182 carry look-ahead unit and ROM or PROM.

Features

- 45 ns cycle time (typ)
- easy expansion to multiple of 2 bits
- 11 general purpose registers
- full function accumulator
- useful functions include:
  2's complement arithmetic
  logical AND, OR, NOT, EXCLUSIVE-NOR
  increment, decrement
  shift left/shift right
  bit testing and zero detection
  carry look-ahead generation
  masking via K-bus
  conditioned clocking allowing non-destructive testing of data in accumulator and scratchpad
- 3 input busses
- 2 output busses
- control bus

Pin configuration — I, N packages


$\overline{I_0}$ 1
$\overline{I_1}$ 2
$\overline{K_0}$ 3
$\overline{K_1}$ 4
X 5
Y 6
$\overline{CO}$ 7
$\overline{RO}$ 8
$\overline{LI}$ 9
$\overline{CI}$ 10
$\overline{EA}$ 11
$\overline{A_1}$ 12
$\overline{A_0}$ 13
GND 14
28 V_{CC}
27 F_2
26 F_1
25 F_0
24 F_3
23 $\overline{ED}$
22 $\overline{M_0}$
21 $\overline{M_1}$
20 $\overline{D_1}$
19 $\overline{D_0}$
18 $\overline{CLK}$
17 F_4
16 F_5
15 F_6

3000KT1000 — 12 package prototyping kit

Central processing unit		
• microprogram control unit	N3001I	(1 x)
• central processing element	N3002I	(4 x)
• carry look-ahead	N74S182B	(1 x)
Microprogram memory		
• 256 x 8 PROM	N82S114I	(3 x)
Input/output		
• 8-bit bidirectional I/O port with latches	N8T31N	(1 x)
• 4-bit bus transceiver	N8T26AB	(2 x)

3000KT8080SK bipolar emulation kit for the 3000 series 8080A system emulator

The 8080 Emulation Kit is a microprogrammable micro-processor utilizing Schottky LSI components to implement an emulation of an Intel 8080A microcomputer system. The emulation is functionally equivalent to a microprocessor system incorporating the following Intel devices: 8080A, 8228, 8224 and 8212. The kit provides the standard address, data, status and control busses as defined in the Intel 8080 Microcomputer System Manual. Since the kit uses bipolar LSI elements, the emulator lacks the two-phase non-overlapping clock. Furthermore, those signals emanating from the 8080 during SYNC time are not provided, but rather the useful status signals provided by the 8228 system controller are implemented. The emulation also provides an extension of the 8228 operation during multi-byte interrupts. This is realized by allowing any 8080 program branch instruction to be inserted during interrupts rather than restricting multi-byte instructions to CALL during interrupts. Finally, a non-standard status signal, RTRAP, is provided which indicates that the present instruction is a reserved or undefined instruction. After this indication, the processor will enter the normal HALT routine and await an interrupt. (Intel 8080A operation during undefined instructions is undefined.) Thus all 12 of the unused instructions in the 8080 instruction set are reserved for future instruction set expansion. These unused codes may be used at any time to extend the usual instruction set without requiring any reprogramming of the bipolar PROMs used for microprogram memory. Finally, the emulator is fully static so that the clock may be adjusted from a typical cycle time of 150 ns to d.c.

The kit contains all the parts necessary to construct the emulator and includes preprogrammed PROMs. The kit is designed to be assembled by a skilled technician in about 8 hours.

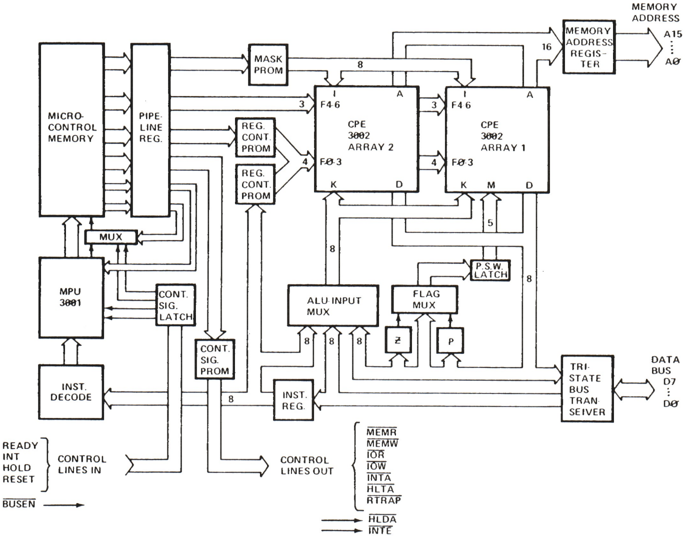
Features

- full emulation of 8080A system
- speed increase by factor of 2 to 9,2 over 8080A system
- static operation; microcycle time d.c. to 150 ns
- operation from single +5 V supply
- executes all 8080 instructions
- hardware multiply and divide
- microprogram expandable
- includes single-phase clock
- full vectored interrupt to any location within 64k memory

Kit contents

1 each	N74123
1 each	N3001
8 each	N3002
7 each	N82S115
1 each	N82S23
2 each	N82S123
2 each	N82S126
3 each	N8263
3 each	N74S182
1 each	N74S280
2 each	N7475
1 each	DM8613
11 each	N74S174
2 each	N8T28
3 each	N8T97
1 each	N74S153
2 each	N74S157
1 each	N7400
1 each	N74S02
3 each	N74S04
1 each	N74S08
1 each	N74S10
1 each	N74S133
2 each	resistor networks 1 kΩ, 16 pin
1 each	P.C. board
1 each	manual
1 each	schematic
1 each	set of microprogram listings
plus:	over 25 miscellaneous resistors, capacitors and other parts

Block diagram



MICRO-CONTROL MEMORY
PIPE-LINE REG.
MASK PROM
REG. CONT. PROM
REG. CONT. PROM
MUX
MPU 3001
CONT. SIG. LATCH
CONT. SIG. PROM
INST. DECODE
INST. REG.
CPE 3002 ARRAY 2
CPE 3002 ARRAY 1
I
A
F4-6
F0-3
K
D
M
ALU INPUT MUX
FLAG MUX
P.S.W. LATCH
Z
P
MEMORY ADDRESS REGISTER
MEMORY ADDRESS
A15
A0
16
TRI-STATE BUS TRANSEIVER
DATA BUS
D7
D0
8
3
4
5
READY
INT
HOLD
RESET
CONTROL LINES IN
BUSEN
CONTROL LINES OUT
MEMR
MEMW
IOR
IOW
INTA
HLTA
RTRAP
HLDA
INTE

8-bit MOS microprocessors 2650, 2650A

The 2650 processor is a general purpose, single chip, fixed instruction set, parallel 8-bit binary processor. It can perform any data manipulations through execution of a stored sequence of machine instructions. The processor has been designed to closely resemble conventional binary computers, but executes variable length instructions of one to three bytes in length. BCD arithmetic is made possible through use of a special "DAR" machine instruction.

The 2650 is manufactured using Signetics' n-channel silicon gate MOS technology. N-channel provides high carrier mobility for increased speed and also allows the use of a single 5 V power supply. Silicon gate provides for better density and speed. Standard 40-pin dual in-line packages are used for the processor.

The 2650 contains a total of seven general purpose registers, each eight bits long. They may be used as a source or destination for arithmetic operations, as index registers and for I/O transfers.

The processor can address up to 32 768 bytes of memory in four pages of 8 192 bytes each. Processor instructions are one, two or three bytes long, depending on the instruction. Variable length instructions tend to conserve memory space since a one or two-byte instruction may often be used rather then a three-byte instruction. The first byte of each instruction always specifies the operation to be performed and the addressing mode to be used. Most instructions use six of the first eight bits for this purpose, with the remaining two bits forming the register field. Some instructions use the full eight bits as an operation code.

The most complex direct instruction is three bytes long and takes 9,6 μs to execute assuming that the processor is running at its maximum clock rate and has an associated memory with cycle and access times of 620 ns or less. The minimum instruction execution time is 4,8 μs.

The clock input to the processor is a single phase pulse train and uses only one interface pin. It requires a normal TTL voltage swing, so no special clock driver is required.

The Data Bus and Address signals are three-state to provide convenience in system design. Memory and I/O interface signals are synchronous so that Direct Memory Access (DMA) and multiprocessor operations are easy to implement.

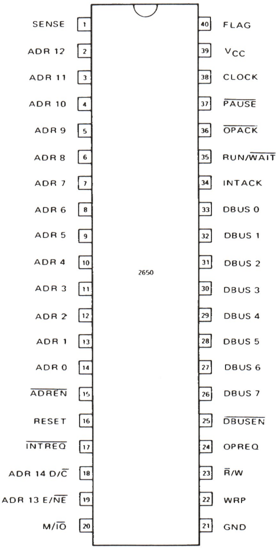
The interrupt mechanism is implemented as a single level, address vectoring type. Address vectoring means that an interrupting device can force the processor to execute code at a device-determined location in memory.

The 2650A is a functional equivalent of the 2650 with a new mask design which provides improved device-operating margins. Both versions are pin-for-pin compatible.

Features

- general purpose processor
- single chip
- fixed instruction set
- parallel 8-bit binary operations
- 40-pin dual in-line package
- n-channel silicon gate MOS technology
- TTL compatible inputs and outputs
- single power supply of +5 V
- seven general purpose registers
- return address stack, 8 deep, on chip
- 32k byte addressing range
- separate address and data lines
- variable length instructions of 1, 2 or 3 bytes
- 75 instructions
- machine cycle time of 2,4 μs at clock frequency of 1,25 MHz
- direct instructions take 2, 3, or 4 cycles
- single phase TTL level clock input
- static logic
- three-state output buses
- register, immediate, relative, absolute, indirect, and indexed addressing modes
- vector interrupt format

Pin configuration — I package



SENSE 1
ADR 12 2
ADR 11 3
ADR 10 4
ADR 9 5
ADR 8 6
ADR 7 7
ADR 6 8
ADR 5 9
ADR 4 10
ADR 3 11
ADR 2 12
ADR 1 13
ADR 0 14
$\overline{\text{ADREN}}$ 15
RESET 16
$\overline{\text{INTREQ}}$ 17
ADR 14 D/$\overline{\text{C}}$ 18
ADR 13 E/$\overline{\text{NE}}$ 19
M/$\overline{\text{IO}}$ 20
2650
40 FLAG
39 V_{CC}
38 CLOCK
37 $\overline{\text{PAUSE}}$
36 $\overline{\text{OPACK}}$
35 RUN/$\overline{\text{WAIT}}$
34 INTACK
33 DBUS 0
32 DBUS 1
31 DBUS 2
30 DBUS 3
29 DBUS 4
28 DBUS 5
27 DBUS 6
26 DBUS 7
25 $\overline{\text{DBUSEN}}$
24 OPREQ
23 $\overline{\text{R}}$/W
22 WRP
21 GND

Addressing modes

The 2650 processor can develop addresses in eight ways:

- register addressing
- immediate addressing
- relative addressing
- relative, indirect addressing
- absolute addressing
- absolute, indirect addressing
- absolute, indexed addressing
- absolute, indirect, indexed addressing

Interface signal definition

ADR0-ADR12 – The low order 13 bits of address for memory access are on these pins. ADR0-ADR7 are also used in two-byte I/O instructions. These outputs are three-state buffers controlled by ADREN.

ADR13-E/$\overline{\text{NE}}$ – This multiplexed output signal delivers the ADR13 address bit when M/IO is in the M phase or discriminates between Extended and Non-Extended I/O instructions when M/IO is in the I/O phase.

ADR14-D/$\overline{\text{C}}$ – Address 14 or Data/Control is a multiplexed output signal. This pin delivers the ADR14 address bit when M/IO is in the M phase or discriminates between Data and Control I/O instructions when M/IO is in the I/O phase.

$\overline{\text{ADREN}}$ – Address Bus Enable is an input providing the external control for the ADR0-ADR12 three-state buffer drivers.

DBUS0-DBUS7 – This is the 8-bit, bidirectional three-state bus over which data is communicated into or out of the processor.

$\overline{\text{DBUSEN}}$ – Data Bus Enable is an input that controls the three-state buffer drivers for DBUS0 to DBUS7.

OPREQ – Operation Request is an output signal that informs external devices that the information on other output pins is valid.

$\overline{\text{OPACK}}$ – Operation Acknowledge is an input which is used by external devices to end an I/O or memory signalling sequence.

M/$\overline{\text{IO}}$ – Memory/Input-Output. This output informs external devices whether Memory or Input/Output functions are being performed.

$\overline{\text{R}}$/W – This output signal describes an I/O or memory operation as Read or Write, and defines whether the bidirectional DBUS is transmitting or receiving.

WRP – This Write Pulse is generated during write sequences and may be used to strobe memory or I/O devices.

SENSE – Is an input, independent of the other I/O signals, that provides a direct input to the processor.

FLAG – This pin provides a direct output signal that is completely independent of the other I/O signals.

$\overline{\text{INTREQ}}$ – Interrupt Request. This input is used by external devices to force the processor into the interrupt sequence.

INTACK – Interrupt Acknowledge is the signal used by the processor to inform external devices that it has entered an interrupt sequence.

$\overline{\text{PAUSE}}$ – Pause is used to temporarily stop the processor at the end of the current instruction. It may stop processing for an indefinite length of time and is available to use for DMA (Direct Memory Access).

RUN/$\overline{\text{WAIT}}$ – Informs external circuits as to the Run/Wait status of the 2650 processor.

RESET – Is an input that resets the program counter to zero and clears the interrupt inhibit bit.

CLOCK – This is the only clock input to the processor. It accepts standard TTL levels.

V_{CC} – +5 V power.

GND – The logic and power supply ground for the processor.

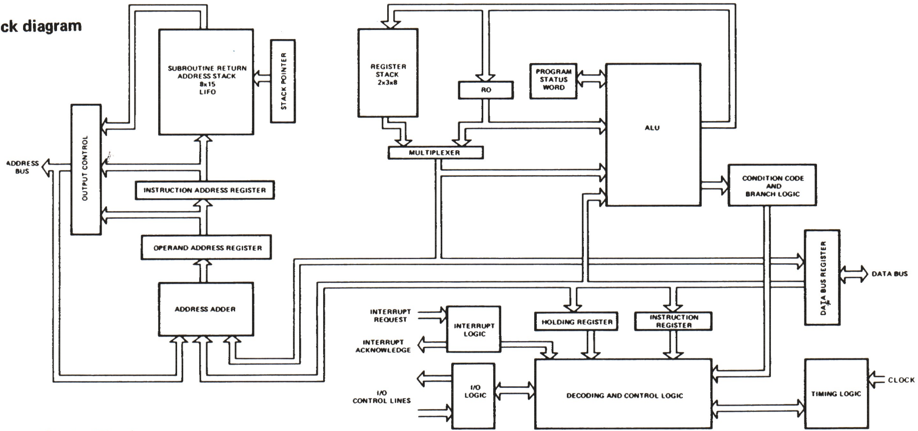
Processor hardware architecture

A block diagram of the processor is shown below. The first, second, and third bytes of instructions are read into the processor on the data bus and loaded into the Instruction Register, Holding Register, and Data Bus Register, respectively. The instructions are decoded through a combination of ROM and random logic.

The ALU performs arithmetic, Boolean, and combinatorial shifting functions. It operates on eight bits in parallel and utilizes carry-look-ahead logic. A second adder is used to increment the instruction address register and to calculate operand addresses for the indexed and relative addressing modes. This separate address adder allows complex addressing modes to be implemented with no increase in instruction execution time.

The General Purpose Register Stack and the Subroutine Return Address Stack are implemented with static RAM cells. The Register Stack consists of seven 8-bit registers. The Subroutine Stack can contain eight 15-bit addresses, thereby allowing eight levels of subroutine nesting. Placing the Subroutine Stack on the chip allows efficient ROM-only systems to be implemented in some applications. Separate 15-bit Instruction Address and Operand Address Registers are provided. The 2650 is an 8-bit binary processor with BCD capability.

Block diagram


SUBROUTINE RETURN ADDRESS STACK 8x15 LIFO
STACK POINTER
OUTPUT CONTROL
ADDRESS BUS
INSTRUCTION ADDRESS REGISTER
OPERAND ADDRESS REGISTER
ADDRESS ADDER
REGISTER STACK 2x3x8
R0
PROGRAM STATUS WORD
ALU
MULTIPLEXER
CONDITION CODE AND BRANCH LOGIC
DATA BUS REGISTER
DATA BUS
INTERRUPT REQUEST
INTERRUPT ACKNOWLEDGE
INTERRUPT LOGIC
HOLDING REGISTER
INSTRUCTION REGISTER
I/O CONTROL LINES
I/O LOGIC
DECODING AND CONTROL LOGIC
TIMING LOGIC
CLOCK

Program Status Word

The Program Status Word (PSW) increases the flexibility and processing power of the 2650. The PSW is a special purpose register within the processor that contains status and control bits. It is divided into two registers called the Program Status Upper (PSU) and Program Status Lower (PSL). The PSW bits may be tested, loaded, stored, preset, or cleared using the instructions which affect the PSW. The bits are utilized as follows:

PSU

7	6	5	4	3	2	1	0
S	F	II	Not Used	Not Used	SP2	SP1	SP0

S	Sense	SP2	Stack Pointer Two
F	Flag	SP1	Stack Pointer One
II	Interrupt Inhibit	SP0	Stack Pointer Zero

PSL

7	6	5	4	3	2	1	0
CC1	CC0	IDC	RS	WC	OVF	COM	C

CC1	Condition Code One	WC	With/Without Carry
CC0	Condition Code Zero	OVF	Overflow
IDC	Interdigit Carry	COM	Logical/Arith. Compare
RS	Register Bank Select	C	Carry/Borrow

microprocessors

technical data – MOS

Instruction set

	mnemonic		op code	format*	description of operation	affects	cycles
Load/Store	LOD	Z	000 000	1Z	Load Register Zero	CC (Note 1)	2
		I	000 001	2I	Load Immediate	CC (Note 1)	2
		R	000 010	2R	Load Relative	CC (Note 1)	3
		A	000 011	3A	Load Absolute	CC (Note 1)	4
	STR	Z	110 000	1Z	Store Register Zero (r ≠ 0)	CC (Note 1)	2
		R	110 010	2R	Store Relative	–	3
		A	110 011	3A	Store Absolute	–	4
Arithmetic	ADD	Z	100 000	1Z	Add to Register Zero w/wo Carry	C, CC (Note 1), IDC, OVF	2
		I	100 001	2I	Add Immediate w/wo Carry	C, CC (Note 1), IDC, OVF	2
		R	100 010	2R	Add Relative w/wo Carry	C, CC (Note 1), IDC, OVF	3
		A	100 011	3A	Add Absolute w/wo Carry	C, CC (Note 1), IDC, OVF	4
	SUB	Z	101 000	1Z	Subtract from Register Zero w/wo Borrow	C, CC (Note 1), IDC, OVF	2
		I	101 001	2I	Subtract Immediate w/wo Borrow	C, CC (Note 1), IDC, OVF	2
		R	101 010	2R	Subtract Relative w/wo Borrow	C, CC (Note 1), IDC, OVF	3
		A	101 011	3A	Subtract Absolute w/wo Borrow	C, CC (Note 1), IDC, OVF	4
	DAR		100 101	1Z	Decimal Adjust Register	CC (Note 2)	3
Logical	AND	Z	010 000	1Z	AND to Register Zero (r ≠ 0)	CC (Note 1)	2
		I	010 001	2I	AND Immediate	CC (Note 1)	2
		R	010 010	2R	AND Relative	CC (Note 1)	3
		A	010 011	3A	AND Absolute	CC (Note1)	4
	IOR	Z	011 000	1Z	Inclusive OR to Register Zero	CC (Note 1)	2
		I	011 001	2I	Inclusive OR Immediate	CC (Note 1)	2
		R	011 010	2R	Inclusive OR Relative	CC (Note 1)	3
		A	011 011	3A	Inclusive OR Absolute	CC (Note 1)	4
	EOR	Z	001 000	1Z	Exclusive OR to Register Zero	CC (Note 1)	2
		I	001 001	2I	Exclusive OR Immediate	CC (Note 1)	2
		R	001 010	2R	Exclusive OR Relative	CC (Note 1)	3
		A	001 011	3A	Exclusive OR Absolute	CC (Note 1)	4
Compare	COM	Z	111 000	1Z	Compare to Register Zero Arithmetic/Logical	CC (Note 3)	2
		I	111 001	2I	Compare Immediate Arithmetic/Logical	CC (Note 4)	2
		R	111 010	2R	Compare Relative Arithmetic/Logical	CC (Note 4)	3
		A	111 011	3A	Compare Absolute Arithmetic/Logical	CC (Note 4)	4
Rotate	RRR		010 100	1Z	Rotate Register Right w/wo Carry	C, CC, IDC, OVF	2
	RRL		110 100	1Z	Rotate Register Left w/wo Carry	C, CC, IDC, OVF	2
Branch	BCT	R	000 110	2R	Branch On Condition True Relative	–	3
		A	000 111	3B	Branch On Condition True Absolute	–	3
	BCF	R	100 110	2R	Branch On Condition False Relative	–	3
		A	100 111	3B	Branch On Condition False Absolute	–	3
	BRN	R	010 110	2R	Branch On Register Non-Zero Relative	–	3
		A	010 111	3B	Branch On Register Non-Zero Absolute	–	3
	BIR	R	110 110	2R	Branch On Incrementing Register Relative	–	3
		A	110 111	3B	Branch On Incrementing Register Absolute	–	3

	mnemonic		op code	format*	description of operation	affects	cycles
Branch	BDR	R	111 110	2R	Branch On Decrementing Register Relative	—	3
		A	111 111	3B	Branch On Decrementing Register Absolute	—	3
	ZBRR		100 110 11	2ER	Zero Branch Relative, Unconditional	—	3
	BXA		100 111 11	3EB	Branch Indexed Absolute, Unconditional (Note 5)	—	3
Subroutine branch/return	BST	R	001 110	2R	Branch To Subroutine On Condition True, Relative	SP	3
		A	001 111	3B	Branch To Subroutine On Condition True, Absolute	SP	3
	BSF	R	101 110	2R	Branch To Subroutine On Condition False, Relative	SP	3
		A	101 111	3B	Branch To Subroutine On Condition False, Absolute	SP	3
	BSN	R	011 110	2R	Branch To Subroutine On Non-Zero Register, Relative	SP	3
		A	011 111	3B	Branch To Subroutine On Non-Zero Register, Absolute	SP	3
	ZBSR		101 110 11	2ER	Zero Branch To Subroutine Relative, Unconditional	SP	3
	BSXA		101 111 11	3EB	Branch To Subroutine, Indexed, Absolute Unconditional (Note 5)	SP	3
	RET	C	000 101	1Z	Return From Subroutine, Conditional	SP	3
		E	001 101	1Z	Return From Subroutine and Enable Interrupt, Conditional	SP, II	3
Input/Output	WRTD		111 100	1Z	Write Data	—	2
	REDD		011 100	1Z	Read Data	CC (Note 1)	2
	WRTC		101 100	1Z	Write Control	—	2
	REDC		001 100	1Z	Read Control	CC (Note 1)	2
	WRTE		110 101	2I	Write Extended	—	3
	REDE		010 101	2I	Read Extended	CC (Note 1)	3
Misc.	HALT		010 000 00	1E	Halt, Enter Wait State	—	2
	NOP		110 000 00	1E	No Operation	—	2
	TMI		111 101	2I	Test Under Mask Immediate	CC (Note 6)	3
Program status	LPS	U	100 100 10	1E	Load Program Status, Upper	F, II, SP	2
		L	100 100 11	1E	Load Program Status, Lower	CC, IDC, RS, WC, OVF, COM, C	2
	SPS	U	000 100 10	1E	Store Program Status, Upper	CC (Note 1)	2
		L	000 100 11	1E	Store Program Status, Lower	CC (Note 1)	2
	CPS	U	011 101 00	2EI	Clear Program Status, Upper, Masked	F, II, SP	3
		L	011 101 01	2EI	Clear Program Status, Lower, Masked	CC, IDC, RS, WC, OVF, COM, C	3
	PPS	U	011 101 10	2EI	Preset Program Status, Upper, Masked	F, II, SP	3
		L	011 101 11	2EI	Preset Program Status, Lower, Masked	CC, IDC, RS, WC, OVF, COM, C	3
	TPS	U	101 101 00	2EI	Test Program Status, Upper, Masked	CC (Note 6)	3
		L	101 101 01	2EI	Test Program Status, Lower, Masked	CC (Note 6)	3

* Format code: The number indicates the number of bytes. The letter(s) indicate the format type(s).

Notes:

1. Condition code (CC1, CC0): 01 if positive, 00 if zero, 10 if negative.
2. Condition code is set to a meaningless value.
3. Condition code (CC1, CC0): 01 if R0 > r, 00 if R0 = r, 10 if R0 < r.
4. Condition code (CC1, CC0): 01 if r > V, 00 if r = V, 10 if r < V.
5. Index register must be register 3 or 3'.
6. Condition code (CC1, CC0): 00 if all selected bits are 1s, 10 if not all selected bits are 1s.

Programmable Communications Interface (PCI)
2651

Applications
- intelligent terminals
- network processors
- front end processors
- remote data concentrators
- computer to computer links
- serial peripherals

The Signetics 2651 PCI is a universal synchronous/asynchronous data communications controller chip designed for microcomputer systems. It interfaces directly to the Signetics 2650 microprocessor and may be used in a polled or interrupt driven system environment. The 2651 accepts programmed instructions from the microprocessor and supports many serial data communication disciplines, synchronous and asynchronous, in the full or half-duplex mode.

The PCI serializes parallel data characters received from the microprocessor for transmission. Simultaneously, it can receive serial data and convert it into parallel data characters for input to the microcomputer.

The 2651 contains a baud rate generator which can be programmed to either accept an external clock or to generate internal transmit or receive clocks. Sixteen different baud rates can be selected under program control when operating in the internal clock mode.

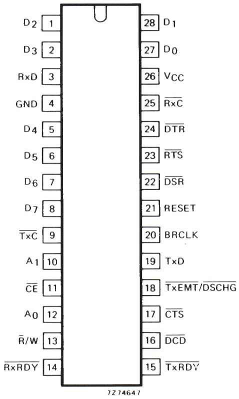
The PCI is constructed using Signetics' n-channel silicon gate depletion load technology and is packaged in a 28-pin DIP.

Features
- Synchronous operation
  - 5 to 8-bit characters
  - single or double SYN operation
  - internal character synchronization
  - transparent or non-transparent mode
  - automatic SYN or DLE-SYN insertion
  - SYN or DLE stripping
  - odd, even, or no parity
  - local or remote maintenance loop back mode
  - baud rate: d.c. to 0,8M baud (1x clock)
- Asynchronous operation
  - 5 to 8-bit characters
  - 1, 1½ or 2 stop bits
  - odd, even, or no parity
  - parity, overrun and framing error detection
  - line break detection and generation
  - false start bit detection
  - automatic serial echo mode
  - local or remote maintenance loop back mode
  - baud rate: d.c. to 0,8M baud (1x clock)
  - d.c. to 50k baud (16x clock)
  - d.c. to 12,5k baud (64x clock)

Pin designation

pin no.	symbol	name and function	type
27, 28, 1, 2, 5-8	D_0-D_7	8-bit data bus	I/O
21	RESET	Reset	I
12, 10	A_0-A_1	Internal register select lines	I
13	$\overline{\text{R}}$/W	Read or write command	I
11	$\overline{\text{CE}}$	Chip enable input	I
22	$\overline{\text{DSR}}$	Data set ready	I
24	$\overline{\text{DTR}}$	Data terminal ready	O
23	$\overline{\text{RTS}}$	Request to send	O
17	$\overline{\text{CTS}}$	Clear to send	I
16	$\overline{\text{DCD}}$	Data carrier detected	I
18	$\overline{\text{TxEMT/DSCHG}}$	Transmitter empty or data set change	O
9	$\overline{\text{TxC}}$	Transmitter clock	I/O
25	$\overline{\text{RxC}}$	Receiver clock	I/O
19	TxD	Transmitter data	O
3	RxD	Receiver data	I
15	$\overline{\text{TxRDY}}$	Transmitter ready	O
14	$\overline{\text{RxRDY}}$	Receiver ready	O
20	BRCLK	Baud rate generator clock	I
26	V_{CC}	+5 V supply	I
4	GND	Ground	I

Pin configuration — I package

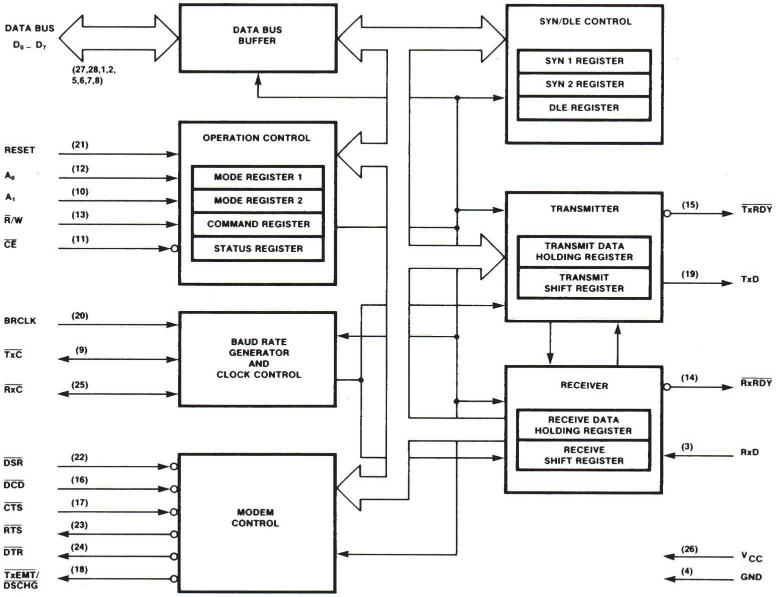


Block diagram

The PCI consists of six major sections. These are the transmitter, receiver, timing, operation control, modem control and SYN/DLE control. These sections communicate with each other via an internal data bus and an internal control bus. The internal data bus interfaces to the microprocessor data bus via a data bus buffer.

Other features

- internal or external baud rate clock
- 16 internal rates – 50 to 19 200 baud
- double buffered transmitter and receiver
- full or half-duplex operation
- fully compatible with 2650 CPU
- TTL compatible inputs and outputs
- single 5 V power supply
- no system clock required
- 28-pin dual in-line package


DATA BUS
$D_0 - D_7$
(27,28,1,2, 5,6,7,8)
DATA BUS BUFFER
SYN/DLE CONTROL
SYN 1 REGISTER
SYN 2 REGISTER
DLE REGISTER
RESET (21)
A_0 (12)
A_1 (10)
$\overline{R}$/W (13)
$\overline{CE}$ (11)
OPERATION CONTROL
MODE REGISTER 1
MODE REGISTER 2
COMMAND REGISTER
STATUS REGISTER
TRANSMITTER
TRANSMIT DATA HOLDING REGISTER
TRANSMIT SHIFT REGISTER
(15) $\overline{TxRDY}$
(19) TxD
BRCLK (20)
$\overline{TxC}$ (9)
$\overline{RxC}$ (25)
BAUD RATE GENERATOR AND CLOCK CONTROL
RECEIVER
RECEIVE DATA HOLDING REGISTER
RECEIVE SHIFT REGISTER
(14) $\overline{RxRDY}$
(3) RxD
$\overline{DSR}$ (22)
$\overline{DCD}$ (16)
$\overline{CTS}$ (17)
$\overline{RTS}$ (23)
$\overline{DTR}$ (24)
$\overline{TxEMT/DSCHG}$ (18)
MODEM CONTROL
(26) V_{CC}
(4) GND

Programmable Communications Interface (continued)

Table 1 Baud rate generator characteristics — crystal frequency = 5,0688 MHz

baud rate	theoretical frequency 16x clock	actual frequency 16x clock	percentage error	duty cycle %	divisor
50	0,8 kHz	0,8 kHz	–	50/50	6336
75	1,2	1,2	–	50/50	4224
110	1,76	1,76	–	50/50	2880
134,5	2,152	2,1523	0,016	50/50	2355
150	2,4	2,4	–	50/50	2112
300	4,8	4,8	–	50/50	1056
600	9,6	9,6	–	50/50	528
1 200	19,2	19,2	–	50/50	264
1 800	28,8	28,8	–	50/50	176
2 000	32,0	32,081	0,253	50/50	158
2 400	38,4	38,4	–	50/50	132
3 600	57,6	57,6	–	50/50	88
4 800	76,8	76,8	–	50/50	66
7 200	115,2	115,2	–	50/50	44
9 600	153,6	153,6	–	48/52	33
19 200	307,2	316,8	3,125	50/50	16

Note

16x clock is used in asynchronous mode. In synchronous mode clock multiplier is 1x and duty cycle is 50% for any baud rate.

Table 2 CPU-related signals

pin name	pin no.	input/output	function
V_{CC}	26	I	+5 V supply input.
GND	4	I	Ground.
RESET	21	I	A high on this input performs a master reset on the 2651. This signal asynchronously terminates any device activity and clears the Mode, Command and Status registers. The device assumes the idle state and remains there until initialized with the appropriate control words.
A_1-A_0	10, 12	I	Address lines used to select internal PCI registers.
$\overline{\text{R}}$/W	13	I	Read command when low, write command when high.
$\overline{\text{CE}}$	11	I	Chip enable command. When low, indicates that control and data lines to the PCI are valid and that the operation specified by the $\overline{\text{R}}$/W, A_1 and A_0 inputs should be performed. When high, places the D_0-D_7 lines in the three-state condition.
D_7-D_0	8, 7, 6, 5 2, 1, 28, 27	I/O	8-bit, three-state data bus used to transfer commands, data and status between PCI and the CPU. D_0 is the least significant bit; D_7 the most significant bit.
$\overline{\text{TxRDY}}$	15	O	This output is the complement of Status Register bit SR0. When low, it indicates that the Transmit Data Holding Register (THR) is ready to accept a data character from the CPU. It goes high when the data character is loaded. This output is valid only when the transmitter is enabled. It is an open drain output which can be used as an interrupt to the CPU.
$\overline{\text{RxRDY}}$	14	O	This output is the complement of Status Register bit SR1. When low, it indicates that the Receive Data Holding Register (RHR) has a character ready for input to the CPU. It goes high when the RHR is read by the CPU, and also when the receiver is disabled. It is an open drain output which can be used as an interrupt to the CPU.
$\overline{\text{TxEMT}}$/$\overline{\text{DSCHG}}$	18	O	This output is the complement of Status Register bit SR2. When low, it indicates that the transmitter has completed serialization of the last character loaded by the CPU, or that a change of state of the $\overline{\text{DSR}}$ or $\overline{\text{DCD}}$ inputs has occurred. This output goes high when the Status Register is read by the CPU, if the TxEMT condition does not exist. Otherwise, the THR must be loaded by the CPU for this line to go high. It is an open drain output which can be used as an interrupt to the CPU.

Multi-Protocol Communications Controller (MPCC)
2652

The 2652 Multi-Protocol Communications Controller (MPCC) is a monolithic n-channel MOS LSI circuit that formats, transmits and receives synchronous serial data while supporting bit-oriented or byte control protocols. The chip is TTL compatible, operates from a single +5 V supply, and can interface to a processor with an 8 or 16-bit bidirectional data bus.

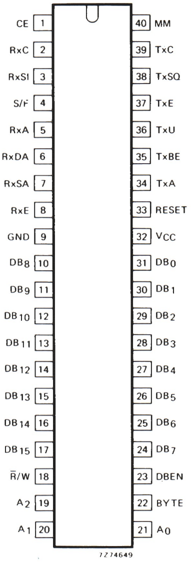
Features

- d.c. to 500k bps data rate
- protocol management
  bit-oriented protocols (BOP): SDLC, ADCCP, HDLC
  byte-control protocols (BCP): BI-SYNC, DDCMP
- programmable operation
  8 or 16-bit three-state data bus
  protocol selection – BOP or BCP
  error control –CRC or VRC or no error check
  character length – 1 to 8-bits for BOP or 5 to 8 bits for BCP
  SYNC or secondary station address comparison for BCP-BOP
  idle transmission of SYNC/FLAG or MARK for BCP-BOP
- automatic detection and generation of special BOP control sequences, i.e., FLAG, ABORT, GA
- zero insertion and deletion for BOP
- short character detection for last BOP data character
- SYNC generation, detection, and stripping for BCP
- maintenance mode for self-testing
- common parameter control registers
- independent status and data registers for receive and transmit
- status indicator signals can be used as CPU interrupts
- TTL compatible
- 40-pin package
- single +5 V supply

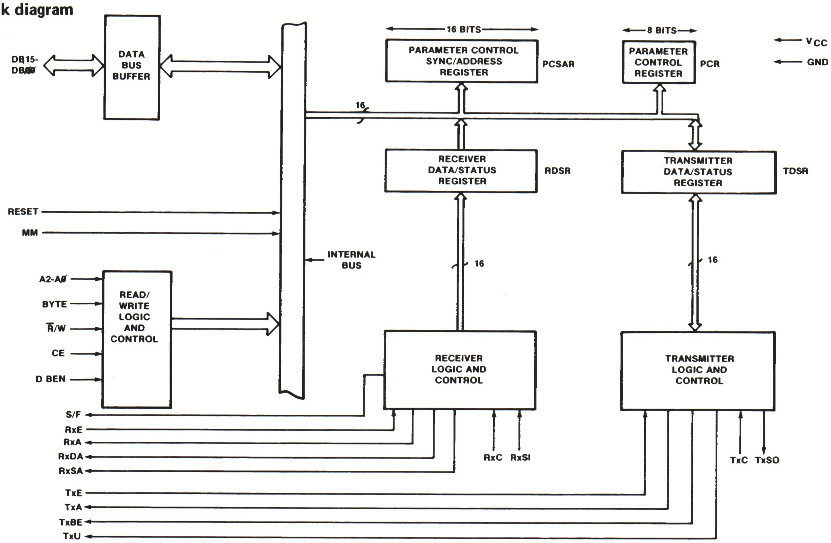
Applications

- intelligent terminals
- network processors
- front end communications
- remote data concentrators
- communication test equipment
- computer to computer links

Pin configuration – I package


CE 1
RxC 2
RxSI 3
S/F 4
RxA 5
RxDA 6
RxSA 7
RxE 8
GND 9
DB8 10
DB9 11
DB10 12
DB11 13
DB12 14
DB13 15
DB14 16
DB15 17
R̄/W 18
A2 19
A1 20
40 MM
39 TxC
38 TxSO
37 TxE
36 TxU
35 TxBE
34 TxA
33 RESET
32 VCC
31 DB0
30 DB1
29 DB2
28 DB3
27 DB4
26 DB5
25 DB6
24 DB7
23 DBEN
22 BYTE
21 A0
7Z74649

MPCC block diagram


DB15-
DB00
DATA
BUS
BUFFER
16 BITS
PARAMETER CONTROL
SYNC/ADDRESS
REGISTER
PCSAR
8 BITS
PARAMETER
CONTROL
REGISTER
PCR
VCC
GND
16
RECEIVER
DATA/STATUS
REGISTER
RDSR
TRANSMITTER
DATA/STATUS
REGISTER
TDSR
RESET
MM
INTERNAL
BUS
16
16
A2-A0
BYTE
R̄/W
CE
D BEN
READ/
WRITE
LOGIC
AND
CONTROL
RECEIVER
LOGIC AND
CONTROL
TRANSMITTER
LOGIC AND
CONTROL
S/F
RxE
RxA
RxDA
RxSA
RxC
RxSI
TxC
TxSO
TxE
TxA
TxBE
TxU

Pin designation

mnemonic	pin no.	type	name and function
DB15-DB00	17-10 24-31	I/O	**Data Bus.** DB07-DB00 contain bidirectional data while DB15-DB08 contain control and status information to or from the processor. Corresponding bits of the high and low order bytes can be WIRE OR'ed into an 8-bit data bus.
A2-A0	19-21	I	**Address Bus.** A2-A0 select internal registers. The four 16-bit registers can be addressed on a word or byte basis. See Register Address section.
BYTE	22	I	**Byte.** Single byte (8-bit) data bus transfers are specified when this input is high. A low level specifies 16-bit data bus transfers.
CE	1	I	**Chip Enable.** A high input permits a data bus operation when DBEN is activated.
R/W	18	I	**Read/Write.** R̄/W controls the direction of data bus transfer. When high, the data is to be loaded into the addressed register. A low input causes the contents of the addressed register to be presented on the data bus.
DBEN	23	I	**Data Bus Enable.** After A2-A0, CE, BYTE and R̄/W are set up, DBEN may be strobed. During a read, the three-state data bus (DB) is enabled with information for the processor. During a write, the stable data is loaded into the addressed register and TxBE will be reset if TDSR was addressed.
RESET	33	I	**Reset.** A high level initializes all internal registers and timing.
MM	40	I	**Maintenance Mode.** MM internally gates TxSO back to RxSI and TxC to RxC for off-line diagnostic purposes. The RxC input is disabled when MM is asserted.

Multi-Protocol Communications Controller (continued)

Pin designation

mnemonic	pin no.	type	name and function
RxE	8	I	**Receiver Enable.** A high level input permits the processing of RxSI data. A low level disables the receiver logic and initializes all receiver registers and timing.
RxA	5	O	**Receiver Active.** RxA is asserted when the first data character of a message is ready for the processor. In the BOP mode this character is the address. The received address must match the secondary station address if the MPCC is a secondary station. In BCP mode, if Strip-SYNC ($PCSAR_{13}$) is set, the first non-SYNC character is the first data character; if Strip-SYNC is zero, the character following the second SYNC is the first data character. In the BOP mode, the closing FLAG resets RxA. In the BCP mode, RxA is reset by a low level at RxE.
RxDA*	6	O	**Receiver Data Available.** RxDA is asserted when an assembled character is in $RDSR_L$ and is ready to be presented to the processor. This output is reset when $RDSR_L$ is read.
RxC	2	I	**Receiver Clock.** RxC (1x) provides timing for the receiver logic. The positive-going edge shifts serial data into the RxSR from RxSI.
S/F	4	O	**SYNC/FLAG.** S/F is asserted for one RxC clock time when a SYNC or FLAG character is detected.
RxSA*	7	O	**Receiver Status Available.** RxSA is asserted when there is a zero to one transition of any bit in $RDSR_H$ except for RSOM. It is cleared when $RDSR_H$ is read.
RxSI	3	I	**Receiver Serial Input.** RxSI is the received serial data. Mark = '1', space = '0'.
TxE	37	I	**Transmitter Enable.** A high level input enables the transmitter data path between $TDSR_L$ and TxSO. At the end of a message, a low level input causes TxSO = 1 (mark) and TxA = 0 after the closing FLAG (BOP) or last character (BCP) is output on TxSO.
TxA	34	O	**Transmitter Active.** TxA is asserted when TxE is high and TSOM ($TDSR_8$) is set. This output will reset when TxE is low and the closing FLAG (BOP) or last character (BCP) has been output on TxSO.
TxBE*	35	O	**Transmitter Buffer Empty.** TxBE is asserted when the TDSR is ready to be loaded with new control information or data. The processor should respond by loading the TDSR which resets TxBE.
TxU*	36	O	**Transmitter Underrun.** TxU is asserted during a transmit sequence when the service of TxBE has been delayed for more than one character time. This indicates the processor is not keeping up with the transmitter (TxSO depends on $PCSAR_{11}$). TxU is reset by RESET or setting of TSOM ($TDSR_8$).
TxC	39	I	**Transmitter Clock.** TxC (1x) provides timing for the transmitter logic. The positive-going edge shifts data out of the TxSR to TxSO.
TxSO	38	O	**Transmitter Serial Output.** TxSO is the transmitted serial data.
V_{CC}	32	PS	+5 V power supply.
GND	9	GND	0 V reference ground.

* Indicates possible interrupt signal.

Programmable Peripheral Interface (PPI)
2655

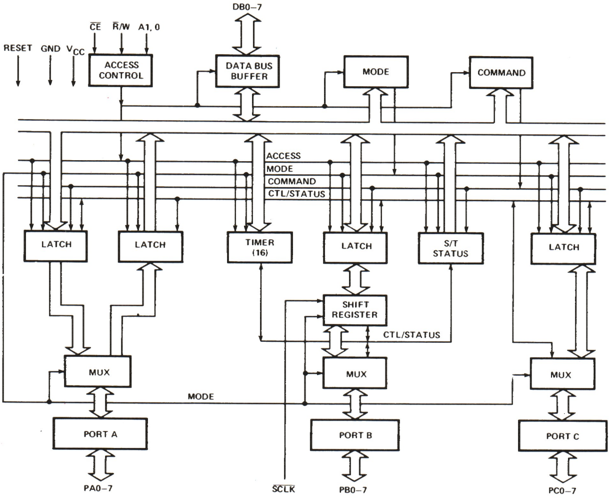
The 2655 PPI is designed for 2650 microcomputer systems. It consists of three ports (24 I/O pins), which can be individually programmed to function as input, output or bidirectional ports. Interface with the 2650 is via an eight-bit bidirectional data bus.

The PPI may be programmed for five major modes of operation: static I/O, strobed I/O, bidirectional I/O, serial I/O, or serial/timer I/O. In the serial/timer mode, parallel-to-serial or serial-to-parallel conversion of data operates simultaneously with the timer on one of the three ports.

Features

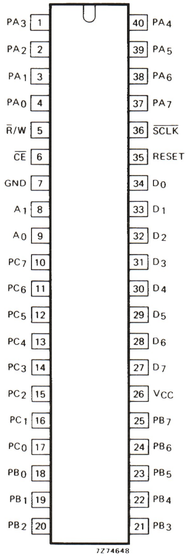
- five selectable major operating modes:
  static I/O
  strobed I/O
  bidirectional I/O
  serial I/O
  serial/timer I/O
- three ports (A, B and C) with 24 programmable I/O pins
- completely TTL compatible
- 3 MHz programmable timer or event counter
- fully compatible with the 2650 microprocessor
- direct bit set/reset capability of each bit for all three ports
- ability to source 1 mA at 1,5 V
- 300 ns port read/write access time
- operates in a polled or interrupt driven system environment
- 40-pin dual in-line package
- single +5 V supply

Block diagram



DB0–7
$\overline{CE}$
$\overline{R}$/W
A1, 0
RESET
GND
V_{CC}
ACCESS CONTROL
DATA BUS BUFFER
MODE
COMMAND
ACCESS
MODE
COMMAND
CTL/STATUS
LATCH
LATCH
TIMER (16)
LATCH
S/T STATUS
LATCH
SHIFT REGISTER
CTL/STATUS
MUX
MUX
MUX
MODE
PORT A
PORT B
PORT C
PA0–7
$\overline{SCLK}$
PB0–7
PC0–7

Pin configuration — I package



PA_3 1
PA_2 2
PA_1 3
PA_0 4
$\overline{R}$/W 5
$\overline{CE}$ 6
GND 7
A_1 8
A_0 9
PC_7 10
PC_6 11
PC_5 12
PC_4 13
PC_3 14
PC_2 15
PC_1 16
PC_0 17
PB_0 18
PB_1 19
PB_2 20
40 PA_4
39 PA_5
38 PA_6
37 PA_7
36 $\overline{SCLK}$
35 RESET
34 D_0
33 D_1
32 D_2
31 D_3
30 D_4
29 D_5
28 D_6
27 D_7
26 V_{CC}
25 PB_7
24 PB_6
23 PB_5
22 PB_4
21 PB_3
7Z74648

Programmable Peripheral Interface (continued)

Operation

The following is a functional description of the five operating modes of the PPI. Each mode is selected via a mode control word. Interrupt generation and interrupt enable/disable functions are available with each mode except the static mode which operates entirely under program control.

Static mode

All three ports can operate in the static I/O mode. This mode allows each pin of each port to be either an input pin or an output pin. A logic '1' written to a pin of a selected port from the 2650 will condition that pin to be an input or output pin. Writing a logic '0' to the pin conditions that pin to be an output pin only. Outputs are latched while inputs are not. Each pin may be set or reset on an individual basis by a "set/reset" command.

Strobed I/O mode

In this mode, data may be transferred to or from a specified port in conjunction with strobe or "handshaking" signals. Ports A and B can operate in the strobed I/O mode and port C bits are used as control and status bits. In this mode both inputs and outputs are latched, and each port can be either an input or output.

Bidirectional I/O mode

This mode provides a means for communicating with a peripheral device over a single eight-bit bus with both transmitting and receiving capability. Port A operates in this mode with Port C pins providing "handshaking" signals for status and control. Both inputs and outputs are latched and port direction is determined by a control signal from the peripheral.

Serial I/O mode

This mode provides a means for communicating with a peripheral device on a bit serial basis through Port B. Parallel data from the CPU will be shifted out to the peripheral over the least significant bit of Port B (PB0). Eight clocks will be required for a complete character transfer. The eight-bit character will be repeatedly shifted out until the CPU presents another character to Port B.

For the serial in mode, data is input from the peripheral at the most significant bit of Port B (PB7). Eight clocks will be required to assemble the eight-bit character. An interrupt request will signal the CPU for character transfer.

Timer mode

This mode enables the PPI to perform time interval measurements, pulse width measurements, and event counting. This timing function is performed during the serial/timer mode, and is restricted to Port B only. The mode is initiated by selecting the desired operation and loading a 16-bit down counter with an initial value. The counter does not start counting until the upper eight bits have been loaded. An interrupt can be generated to signal the CPU when the timer reaches a zero count.

Pin definitions

pin no.	pin name	type	function
27-34	D7-D0	I/O	Eight-bit three-state bidirectional data bus. All data and command transfers are made using this bus. D0 is the least-significant bit; D7 is the most-significant bit.
35	Reset	I	Resets all internal storage elements, including the data latches and command registers. Resets ports A, B and C to accept input data, and operating mode to static mode. A functionally equivalent on-chip power-on reset is also provided.
8, 9	A1, A0	I	Address lines used to select internal PPI modes or registers. Indicates control or data words to be placed on the data bus. Used in conjunction with the $\bar{\text{R}}$/W line.
5	$\bar{\text{R}}$/W	I	When low, gates the selected register to the data bus. When high, gates the contents of the data bus into the selected register.
6	$\overline{\text{CE}}$	I	When low, identifies that control and data lines to the PPI are valid.
36	$\overline{\text{SCLK}}$	I	Provides a serial clock for the parallel-to-serial or serial-to-parallel conversion.
37-40 1-4	PA7-PA0	I/O	An eight-bit three-state quasi-bidirectional port.* PA0 is the least-significant bit; PA7 is the most-significant bit.
25-18	PB7-PB0	I/O	An eight-bit quasi-bidirectional port.* PB0 is the least-significant bit; PB7 is the most-significant bit. Port B also has parallel-to-serial or serial-to-parallel conversion capability with PB0, 7 being either the serial output or input respectively. Data is double buffered. Port B can also operate as a 16-bit binary timer, as an event counter, or as a pulse width indicator. An output is generated whenever the counter is decremented to the all-zero state.
10-17	PC7-PC0	I/O	A eight-bit quasi-bidirectional port.* PC0 is the least-significant bit; PC7 is the most-significant bit. Port C bits are also used as control and status signals in conjunction with ports A and B. When the pin bit is used as a strobe input, the line receives an external strobe input which clocks information from port A or port B into the port A or port B data latches. When the pin is used as a status line, the line indicates port A or port B status condition which may be used as an interrupt input to the 2650.
26	V_{CC}	I	+5 V supply.
7	GND	I	Ground.

* A quasi-bidirectional port allows each bit to be designated as input or output under program control. If any bit of the port is set to a '1', that bit becomes an input or output depending on the usage of the port pin. If the peripheral is driving the port bit (i.e. overriding the logic '1' condition produced by the internal port pull-up resistor), then the bit is an input. If the peripheral is receiving from the port bit, then a '0' or '1' written to the port will be transmitted to the peripheral.

System Memory Interface (SMI)
2656

The 2656 System Memory Interface (SMI) is a mask programmable circuit with on-chip memory, I/O, and timing (clock) functions. It is usable either in 2-chip or multi-chip microcomputer systems. Used with the 2650 microprocessor, it provides a 2-chip microcomputer. This 2-chip microcomputer offers the user 2kx8 bits of ROM, 128x8 bits of RAM, and an 8-bit multi-function I/O port.

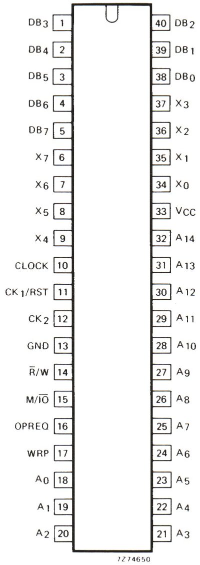
Used as a system interface in a multi-chip microcomputer, with large memory and/or additional peripheral requirements, the programmable versatility of the SMI provides decoded chip enable outputs. These outputs connect directly to other memory or I/O functional blocks with few, if any, requirements for additional interfacing chips. This reduces both chip count and cost in complex microcomputer systems.

The 2656 is processed using Signetics' n-channel silicon gate technology. Only a single power supply of +5 V is needed.

Features

- 2kx8 mask programmable ROM
- 128x8 static RAM
- 8 multi-purpose pins for either chip enables or I/O bits
- 8-bit latch for either I/O or MPU storage
- internal clock generator with crystal, RC, or external timing source
- system power-on reset
- 40-pin dual in-line package
- single +5 V supply
- 2-chip microcomputer
- system control for multi-chip microcomputers – eliminates or reduces TTL support circuitry for memory and I/O device selection
- from small (2k-2 chip) to 32k microprocessor-based systems.

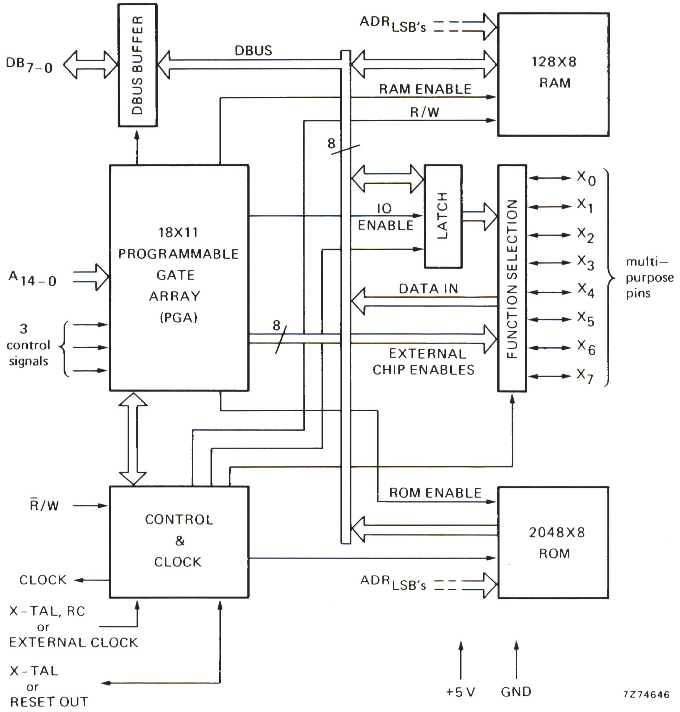
Pin configuration – I package


DB3 1
DB4 2
DB5 3
DB6 4
DB7 5
X7 6
X6 7
X5 8
X4 9
CLOCK 10
CK1/RST 11
CK2 12
GND 13
R̄/W 14
M/ĪŌ 15
OPREQ 16
WRP 17
A0 18
A1 19
A2 20
40 DB2
39 DB1
38 DB0
37 X3
36 X2
35 X1
34 X0
33 VCC
32 A14
31 A13
30 A12
29 A11
28 A10
27 A9
26 A8
25 A7
24 A6
23 A5
22 A4
21 A3
7Z74650

Pin definitions

pin no.	pin name	function
38-40, 1-5	DB_0-DB_7	8-bit bidirectional data bus. All data transfers between the MPU and ROM, RAM, Latch and X pins are made using this bus.
15-32	PGA inputs	18 PGA inputs that are used to determine SMI operation during the current MPU cycle. These inputs should include:
18-32	A_0-A_{14}	● MPU address bus. Address bus inputs occupy contiguous bit positions with A_0 as the least-significant address bit.
16	OPREQ	● A control signal that specifies the valid state of address and control bus.
15, 17	$M/\overline{IO}$, WRP	● Optional signals. Possibilities include Memory or I/O ($M/\overline{IO}$), Write Pulse (WRP), external control signals, or additional high order address bits.
14	$\overline{R}/W$	A control signal from the MPU that indicates whether the requested operation is to be a Read or Write (0 or 1 respectively). This signal must not change while OPREQ is true.
10	CLOCK	Output clock to the MPU. The frequency is determined by the timing element and the mask programmable divisor (divided by 1, 2, 3, 4).
11, 12	CK_1/RST, CK_2	Connections for the timing element. Only CK_2 is necessary for an RC or external timing source. The CK_1/RST pin then becomes a power-on RESET output. Two pins are necessary for direct connection of a crystal.
33, 13	V_{CC}, GND	Power supply connection and ground.
34-37, 9-6	X_0-X_7	Multi-purpose I/O pins. These pins can be mask programmed as external memory or I/O Chip Enables, or bidirectional I/O Port data bits, or any combination of the two.

System Memory Interface (continued)


DB7–0
DBUS BUFFER
DBUS
ADR LSB's
128X8
RAM
RAM ENABLE
R/W
8
18X11
PROGRAMMABLE
GATE
ARRAY
(PGA)
A14–0
3
control
signals
IO
ENABLE
LATCH
FUNCTION SELECTION
DATA IN
8
EXTERNAL
CHIP ENABLES
X0
X1
X2
X3
X4
X5
X6
X7
multi–
purpose
pins
R̄/W
CONTROL
&
CLOCK
CLOCK
X-TAL, RC
or
EXTERNAL CLOCK
X-TAL
or
RESET OUT
ROM ENABLE
2048X8
ROM
ADR LSB's
+5 V
GND
7Z74646

Functional block descriptions

Data Bus Buffer

A three-state bidirectional 8-bit bus transceiver for data transfer between the SMI and MPU.

Programmable Gate Array (PGA)

Provides select signal outputs for the internal ROM, RAM, Latch, and up to 8 multi-purpose I/O pins that are mask-programmed as Chip Enables. A PGA output is active when the input variables match any one of 11 corresponding mask-programmed product terms. The 18 input variables are normally address and control bus signals from the MPU and may be programmed as '1', '0', and 'don't care'. Each product term is a specified combination of the input variables.

Control and Clock

Generates the CLOCK output signal to the MPU and control signals for the ROM, RAM, and LATCH. A mask programmable frequency divider provides input frequency division by 1, 2, 3 or 4. The timing source is mask programmable and may be a crystal, RC, or external oscillator. If either of the latter two are designated as a timing source, the second timing pin becomes a RESET output to the MPU.

ROM

2 048 bytes of mask-programmable Read Only Memory for storage of instructions and constants. The ROM base address is PGA mask programmable over the entire MPU address range. The ROM can be disabled by a mask option.

RAM

128 bytes of Read/Write Memory for MPU data storage and retrieval. The RAM base address is PGA mask programmable over the entire MPU address range. RAM dominates over ROM if address overlap is intentionally mask programmed. The RAM can be disabled by a mask option.

Function Select (FS)

A 1 x 8 Function Select array of mask-programmable contacts determine the function of each of the multi-purpose I/O pins (X_0-X_7). Two modes exist:

1. CE – The X pin is an active low Chip Enable ($\overline{CE}$) for either external memory or an I/O port. PGA inputs receive the external address and MPU control signals required to generate the $\overline{CE}$ output.
2. P – The X pin is a bidirectional I/O Port Data bit. A portion of the PGA provides the control signal to select the Port.

Latch

Holds output data for the multi-purpose I/O pins mask programmed as a mode P. The latch continues to function as a read/write element even if all multi-purpose I/O pins are programmed as chip enables. Thus, any X pin that is programmed as an external chip enable can have corresponding latch bits available for temporary data storage or software flags. To read an input pin, the corresponding latch bit must first be written to a '1' by the MPU program.
This is done to disable all active outputs, changing them to passive pull-up outputs. This permits inputs to be sensed on the same pin. Subsequent reads of the same pin do not have to be preceded by a write if the state of the latch pin remains a '1'.

2650PC4000 Emulator board for 2656

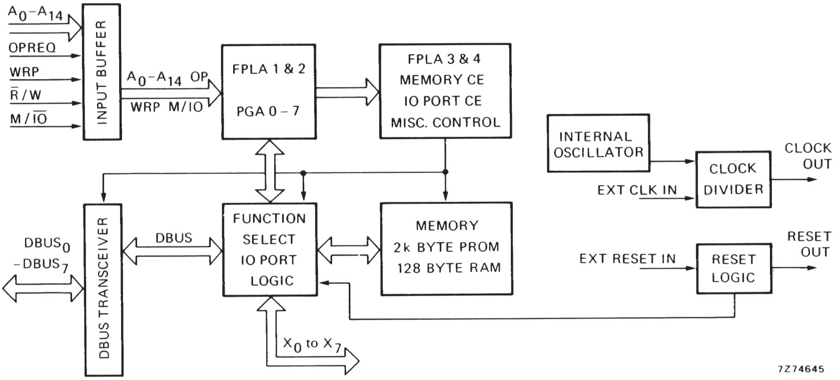
The PC4000 is a circuit emulation of the 2656, a 40-pin NMOS-LSI system memory interface chip. The PC4000, in circuit board form, offers the engineer a system design aid. By designing with the PC-board emulator, specific ROM and PGA (programmable gate array) patterns can be determined for the user's application.

In utilizing the PC4000, the engineer-designer is able to implement the same functions as the 2656. Through a cable and 40-pin plug with a pin configuration identical to the 2656, the user connects the PC4000 directly into his prototype system. He can access the 128x8 RAM, the preprogrammed ROM, and the gate array. The user can simulate the eight multi-function ports either as I/O ports or chip enables, the power-on reset, and the clock generator and divider.

The PC4000 emulator contains the same circuits that are available to the user on the 2656 Systems Memory Interface chip. Functionally the PC4000 replaces the 2656 in the user's prototyping system through a pin-for-pin compatible plug and its 40-wire ribbon cable attached to the PC4000. Identical circuit functionality of the 2656 chip is provided to the user by the functions of the PC Board.

In emulating the 2656, the speed of the board circuitry is equivalent to or faster than the on-chip circuitry. ROM is implemented with bipolar PROMs and on-chip RAM is implemented with the bipolar RAM packages. The programmable gate array (PGA) for the selection of the ROM and RAM enables and the I/O function selects are implemented with field programmable logic arrays (FPLAs).

The oscillator provided on the PC4000 has the same frequency dividers available as on the 2656. The oscillator divide ratio is implemented by the toggle switch settings.


A_0–A_{14}
OPREQ
WRP
$\overline{R}$/W
M/$\overline{IO}$
INPUT BUFFER
A_0–A_{14} OP
WRP M/IO
FPLA 1 & 2
PGA 0 – 7
FPLA 3 & 4
MEMORY CE
IO PORT CE
MISC. CONTROL
INTERNAL OSCILLATOR
CLOCK DIVIDER
CLOCK OUT
EXT CLK IN
DBUS$_0$ – DBUS$_7$
DBUS TRANSCEIVER
DBUS
FUNCTION SELECT IO PORT LOGIC
MEMORY
2k BYTE PROM
128 BYTE RAM
EXT RESET IN
RESET LOGIC
RESET OUT
X_0 to X_7
7Z74645

Functional block descriptions

Input Buffer

This circuitry buffers the incoming signals from the MPU (specifically for the 2650 MPU, the addresses, A0-A14, and the 4 control signals, OPREQ, WRP, $\overline{R}$/W and M/$\overline{IO}$).

Data Bus Transceiver

This circuitry buffers the incoming 8-bit data bus from the MPU, and provides output drivers to the data bus.

FPLAs 1 and 2

FPLAs 1 and 2 represent a portion of the programmable gate array of the 2656 SMI chip. These 2 FPLAs decode the chip enable signals.

FPLAs 3 and 4

These FPLAs represent the remainder of the gate array. FPLA 3 and a portion of FPLA 4 generate the on-board ROM, RAM and port enable signals. The remainder of FPLA 4 is used to generate the data bus control signals.

Function Select and I/O Port Logic (via FPLAs 1-4)

The function select and I/O port logic allow the multi-purpose pins of the 2656 to be individually selected as either an I/O port or a chip enable via eight switches, FS0-FS7. When assigned as chip enables, they must be programmed in FPLAs 1 and 2. When a multi-purpose pin is assigned as I/O or as an input port, the port address is programmed in FPLAs 1 and 2. When the FS switch is ON, the corresponding pin of the 2656 is selected as an I/O port. When the FS switch is OFF, the corresponding pin is selected as a chip enable.

Memory

Both ROM and RAM memory functions are implemented in bipolar PROM and RAM respectively. The memory chip enables are programmed in FPLAs 3 and 4. (See the PROGRAMMING section.)

Clock Divider, Reset Logic, and Internal Oscillator

This circuitry provides an internal oscillator with switches for frequency divide by 1, 2, 3 or 4. Reset logic is provided on the PC4000 to allow the user to reset the system during debug via an external switch closure, without the need for powering down. The reset logic is used when the RC or external oscillator modes are selected.

If the RC or crystal internal oscillator mode is desired, the frequency determining components must be installed on the emulator PCB. The pins on the header that correspond to the RC and Crystal pins are not used in this mode, and only the external Reset function is provided.

Part list

part number	quantity	description
7403	2	Open Collector Quad Nand
7404	3	Hex Inverter
7405	2	Open Collector Hex Inverter
74LS14	1	Hex Schmitt Trigger Inverter
7432	1	Quad 2-Input OR gate
74LS86	1	Quad 2-Input XOR
74109	1	Dual JK Flip-Flop
74116	1	Dual Quad D Latch with Clear
74126	4	Quad Three-state Buffer
74163	1	4-bit Binary Counter
8T28B	2	Bidirectional Data Bus Driver Receiver
8T97B	5	Three-state Hex Buffer
8T98B	2	Three-state Hex Inverter Buffer
82S101	4	Open Collector FPLA
82S115	4	512x8 PROM
82S09	2	64x9 BIPOLAR RAM
NE555	1	Timer
761-1-51,0 kΩ	4	Resistor Dip Pak
	1	10 kΩ Resistor
	1	100 kΩ Resistor
	1	220 Ω Resistor
		Note: All Resistors ¼ watt
	1	150 pF Capacitor
	2	0,01 µF Capacitor
	5	4,7 µF Capacitor
	14	0,1 µF Capacitor
	1	Edge Connector AMP 225-21021-401-117
	2	8-Position Dip Switch
	1	PC Board 2650/PC4000
	4	24-pin Dip Socket
	4	28-pin Dip Socket
	1	40-pin Dip Socket
	1	Cable Assembly

Required but not supplied:
Timing element for oscillator.

Emulator board for 2656 (continued)

40-core cable pin configuration

The interface from the PC4000 to the user's system is a 40-core cable with 40-pin DIP plugs at both ends.

function	pin no.	pin no.	function
DBUS3	1	40	DBUS2
DBUS4	2	39	DBUS1
DBUS5	3	38	DBUS0
DBUS6	4	37	X3
DBUS7	5	36	X2
X7	6	35	X1
X6	7	34	X0
X5	8	33	NC*
X4	9	32	ADDR14
CLK OUT	10	31	ADDR13
CLK 1	11	30	ADDR12
CLK2	12	29	ADDR11
VSS GND	13	28	ADDR10
R/W	14	27	ADDR9
M/I/O	15	26	ADDR8
OPREQ	16	25	ADDR7
WRP	17	24	ADDR6
ADDR0	18	23	ADDR5
ADDR1	19	22	ADDR4
ADDR2	20	21	ADDR3

* VDD for chip, no connection for board.

Note: Timing Element pins have alternative functions determined by connections W on the printed circuit board.
CLK 1 is external reset out. To use, connect W (4) to W (5).
CLK 2 is external clock in. To use, connect W (2) to W (3).
CLK 2 not used: To use internal RC oscillator connect W (1) to W (2).
To use internal XTAL oscillator connect W (2) to W (8).

Edge connector

The edge connector for the 2650PC4000 is an AMP 225-21021-4-01-117 edge connector. This edge connector has 20 pins on 0,156 inch centres with the following pin configuration:

GND	1	A	GND
GND	2	B	GND
	3	C	C2X
	4	D	
	5	E	RESET OUT**
	6	F	CLK OUT**
	7	H	RESET IN**
CK	8	J	OSC**
VCC	9	K	VCC
VCC	10	L	VCC

** Factory test only – do not use.

Microprocessor prototyping card
2650PC1001

The 2650PC1001 is a complete microcomputer on a single printed circuit board. The heart of this computer is Signetics' 2650 Microprocessor; a single chip, n-channel MOS Integrated Circuit which contains the CPU and control sections of the classical general purpose computer architecture.

In addition to the Microprocessor, the 2650PC1001 contains both control and read/write memory, I/O ports, clock, and all the necessary buffering and interface circuits to permit data transfer both on and off the p.c.b.

Features

- 2650 Microprocessor
- 1k bytes of ROM with PIPBUG*
- 1k bytes of RAM (off-board expandable)
- 1 MHz crystal oscillator
- serial I/O (either TTY 20 mA current loop or RS232 – selectable by jumper wire)
- 2 eight-bit output ports
- 2 eight-bit input ports
- DMA capability
- LED display indicators
- data bus and address bus test points
- buffered data and address outputs
- single power supply (+5 V)**

* Signetics' Loader and Debugging Program. (See appl. note SS50)

** Assumes RS232 I/O port is not used.

Memory

The memory of the 2650PC1001 is divided into two segments:

a. ROM with PIPBUG

b. RAM (Read/Write Memory)

The Read-Only Memory supplied with the card is the 82S129 Field Programmable type (PROM). Eight of these 256x4 devices are arranged to provide a 1kx8 memory array. The 2650PC1001 is supplied with the PIPBUG loader and debugger already programmed into the ROM. Since the devices are loaded into sockets, however, they can be easily replaced with other ROMs or PROMs programmed by the user.

The 1kx8 array is constructed with 2606 NMOS RAM devices. Since the 2606 is a 256x4 device, again 8 devices are used in the array.

Serial I/O

The serial I/O capability of the 2650PC1001 utilizes a unique serial I/O feature of the basic 2650 microprocessor. This feature allows serial data to be transferred directly into the 2650 under program control by using the sense and flag pins on the microprocessor.

Two types of serial I/O ports are available. The first is a teletype interface which can be directly connected to a teletype 20 mA current loop. The second is an RS232 interface which provides a connection for voltage-driven peripheral equipment. The selection of the particular interface to be used is made by connecting a jumper wire directly from the microprocessor flag and sense lines to the appropriate output port. If the RS232 interface is used, +12 and –12 V supplies are required in addition to the +5 V supply which operates the rest of the board.

Parallel I/O

Parallel I/O channels using the 2650's unique Non-Extended I/O mode are also provided. This mode allows a single byte instruction to select one of two distinct I/O devices. On the 2650PC1001, these two devices are represented by four separate data channels; two for reading and two for writing. The output (or write) channels are fully latched and buffered. The input (or read) channels are fully buffered. One read and one write channel represent a single I/O device. In addition to the Non-Extended I/O ports, the data and address buses, plus the appropriate control signals, are also available to provide the full extended I/O capability.

Microprocessor prototyping card (continued)

Other I/O

A complete listing of the I/O pins, plus a brief description of any I/O signal not detailed above, is as follows:

1,2	Ground
4-11	Processor Data Bus*
12	Strobe to Enable Input Data Port
13	D/C Output*
14	DMA Control Input
15	Extended/Non-Extended Output*
16	Interrupt Acknowledge Output*
17	R/W Output*
18	Write Pulse Output*
19	Run/Wait Output*
20	Operation Request Output*
21	Memory/IO Output*
22	Operation Acknowledge Input*
23	Clock Output (or Input if on-board clock not used)
24	Operation Request Input for DMA
25	Reset Input*
26	Interrupt Request Input*
27	Pause Input*
28-32	Unused
33-47	Address Bus*
48	+12 V for RS232
49	–12 V for RS232
50	+5 V
A, B	Ground
C	Not used
D-M	Non Extended Output Port "D"
N	Clock to load data into Output Port "D"
P	TTY serial data input (+)
R	TTY serial data input (–)
S	TTY serial data Output pull-up resistor (current loop +)
T	TTY serial data Output; TTL Level, open collector (current loop return)
U	RS232 ground
V	RS232 Output
W	TTY tape reader Output; TTL Level, open collector (+)
X	TTY tape reader Output pull-up resistor (–)
Y	RS232 Input
Z	Clock to load data into Output Port "C"
a-h	Non-Extended Output Port "C"
j	Strobe to enable Input Port Control
k-u	Non-Extended Input Port "D"
v-c	Non-Extended Input Port "C"
d	+12 V for RS232
e	–12 V for RS232
f	+5 V

Summary

The above is intended to provide a brief description of Signetics' 2650PC1001 Prototyping Board. More detailed information can be obtained from the following:

SS50	PIPBUG Application Note
SP50	2650PC1001 Manual (Detailed Description)
AS50	Serial I/O using Sense and Flag Application Note
2650BM 1000	Basic 2650 Microprocessor Manual

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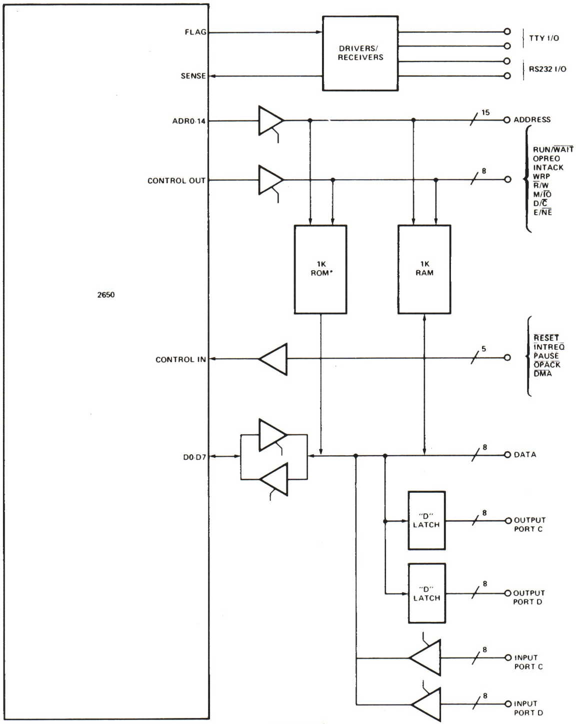
* Buffered 2650 microprocessor outputs.

PC1001 Block diagram


2650
FLAG
SENSE
ADR0-14
CONTROL OUT
CONTROL IN
D0-D7
DRIVERS/ RECEIVERS
TTY I/O
RS232 I/O
15
ADDRESS
8
RUN/WAIT
OPREQ
INTACK
WRP
R/W
M/IO
D/C
E/NE
1K ROM*
1K RAM
5
RESET
INTREQ
PAUSE
OPACK
DMA
8
DATA
"D" LATCH
8
OUTPUT PORT C
"D" LATCH
8
OUTPUT PORT D
8
INPUT PORT C
8
INPUT PORT D

*WITH PIPBUG

Adaptable Board Computer (ABC) prototyping system
2650PC1500
2650KT9500

The Adaptable Board Computer, ABC 1500, is a modular microcomputer containing a CPU, memory, I/O ports and support circuitry. It is designed to cover a broad range of applications from software development to system hardware prototyping. Cost performance trade-offs have been carefully considered to achieve maximum flexibility and allow the card to be tailored to a variety of individual requirements.

The basic configuration consists of the 2650 8-bit microprocessor, 512 bytes of read/write memory (four 2112 static RAMs), 1k bytes of 2608 ROM with PIPBUG*, two 8T31 I/O ports and buffering on data, address and control lines. A single +5 V supply will be required to power the card and communicate with a serial 20 mA current loop terminal.

Modifications to the basic system can be easily made to allow for various memory configurations and operating modes. Unused plated-through holes are provided for the PROM memory chips (82S115s). Other options are jumper selectable. The area on the card associated with each jumper is identified with a "Wx" mnemonic.

The ABC 1500 is sold either as a completely assembled and tested card (2650PC1500) or in kit form (2650KT9500).

Features

- expandable printed circuit card:
  unused area on card filled with plated-through holes on 7,5 mm centres for wire-wrap sockets
- 1k bytes of PIPBUG* ROM (in socket)
- 512 bytes of RAM
- two latched I/O ports
  – four non-extended I/O read/write user strobes
- three-state buffers on data, address and control lines
- serial input/output port
- single +5 V supply requirement (1,7 A max) for card and 20 mA current loop interface (±12 V supply for RS232 interface)
- simple memory and I/O port decoding with two 16-pin DIPs
- interrupt and single step capability
- simple clock configured from dual monostable multivibrator
- 24k memory expansion capability
- directly compatible with 4k RAM card (2650PC2000) and power supply demonstration base (2650DS2000)
- card dimensions: 20 cm by 17,5 cm with a 100-pin connector along the 20 cm dimension

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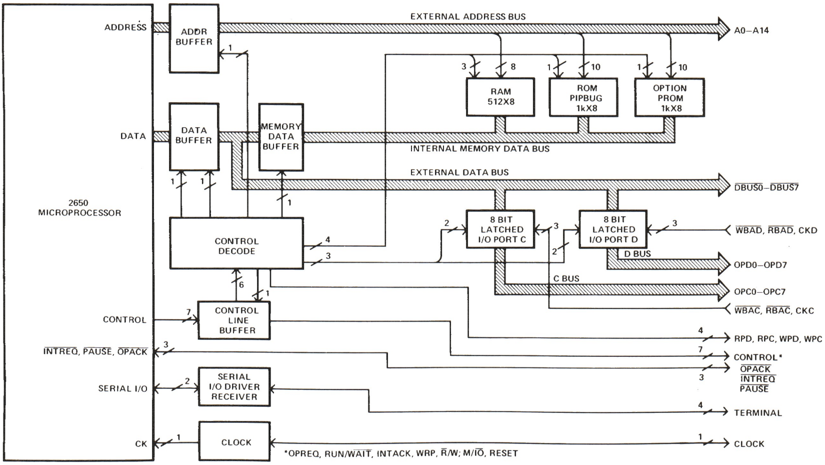
* PIPBUG is a loader, editor, and debug program. See Table 1.


ADDRESS
ADDR BUFFER
EXTERNAL ADDRESS BUS
A0–A14
1
3
8
1
10
1
10
RAM 512X8
ROM PIPBUG 1kX8
OPTION PROM 1kX8
DATA
DATA BUFFER
MEMORY DATA BUFFER
INTERNAL MEMORY DATA BUS
EXTERNAL DATA BUS
$\overline{DBUS0}$–$\overline{DBUS7}$
2650 MICROPROCESSOR
1
1
1
2
3
3
8 BIT LATCHED I/O PORT C
8 BIT LATCHED I/O PORT D
$\overline{WBAD}$, $\overline{RBAD}$, CKD
CONTROL DECODE
4
3
2
D BUS
OPD0–OPD7
C BUS
OPC0–OPC7
6
1
$\overline{WBAC}$, $\overline{RBAC}$, CKC
CONTROL
7
CONTROL LINE BUFFER
4
RPD, RPC, WPD, WPC
$\overline{INTREQ}$, $\overline{PAUSE}$, $\overline{OPACK}$
3
7
CONTROL*
3
$\overline{OPACK}$
$\overline{INTREQ}$
$\overline{PAUSE}$
SERIAL I/O
2
SERIAL I/O DRIVER RECEIVER
4
TERMINAL
CK
1
CLOCK
1
CLOCK

*OPREQ, RUN/$\overline{WAIT}$, INTACK, WRP, $\overline{R}$/W; M/$\overline{IO}$, RESET

Options

- 1k bytes of PROM in place of ROM
- 512 bytes of PROM or ROM in place of RAM
- asynchronous operation capability
- external clock input
- interrupt vector from port C

Interface

- terminal interface jumper selectable
  a. W4 to W5 and W6 to W7 jumpers select the 20 mA current loop mode
  b. W3 to W4 and W7 to W8 jumpers select the RS232 mode
- normally high input lines (10 kΩ pull-up resistor on each): $\overline{\text{INTREQ}}$, $\overline{\text{PAUSE}}$, $\overline{\text{RESET}}$, $\overline{\text{WBAC}}$, $\overline{\text{WBAD}}$, CKC, CKD
- plated-through holes are available at each connector pin to allow for insertion of wire-wrap pins
- edge connector supplied with card
- to allow for external clock input, remove jumper W9-W10
- asynchronous operation by removing jumper W1 to W2 and driving $\overline{\text{OPACK}}$
- during vectored interrupts, it is possible to allow port C to place the interrupt address on the data bus by removing jumper W21-W22 and jumpering W22-W23

Table 1 PIPBUG commands

alpha character input	command
A	alter memory
B	set breakpoint
C	clear breakpoint
D	dump memory to papertape
G	go to address
L	load memory from papertape
S	see and alter registers

Note: The program is entered by resetting the card. The terminal will then respond with an asterisk (*).

Memory configuration

All of page 0 is reserved for on-card memory (0 to 8191_{10}). Address lines A9, A11 and A12 are not decoded (Don't care signals) allowing two ICs to perform not only memory decoding but also I/O port decoding. As an added benefit, usable memory space exists at the top of page 0 (see memory map) due to the interleaving effect between the ROM and RAM memories. This memory space can be used as interrupt vector address locations in a negative direction from address location "0" (a negative relative instruction from address location "0" wraps around the first 8k page).

There is a total of two blocks in the RAM structure, each of which contains 256 bytes of RAM. Since PIPBUG uses the first 63 RAM locations for temporary storage, the first actual user location is 1087_{10} ($43F_{16}$) (there are seven other address locations corresponding to the first user location – see memory map). Starting at $43F_{16}$, the range for on card RAM extends to address 1535_{10} ($5FF_{16}$), giving a total usable on-card space of 449 bytes.

The first external memory location for add-on memory is 8192_{10} (2000_{16}). All of page 1, 2, and 3 are available, giving a total memory expansion capability of 24k.

Memory options

Modifications to the basic configuration can be made to provide a mix of RAM/PROM/ROM memories. PROM memories can be used in place of the PIPBUG ROM by removing the ROM from its socket and adding one or two 82S115 PROMs (512x8). Area and plated-through holes are provided on the card for insertion of sockets for the PROMs or the PROMs themselves. Decoding for the PROMs has been provided by ABC 1500 logic.

Data and address lines for 2112 RAMs and 82S129 PROMs or 82S229 ROMs are identical. It is, therefore, possible to use PROMs and/or ROMs in place of RAM. This option will require removal of the RAMs (two per block), and changing the jumper for each 256 byte block of PROM or ROM added. The jumper needed for each block of memory is as follows:

memory section	RAM jumper	PROM/ROM jumper
first block	W12-W13	W11-W13
second block	W15-W16	W14-W16

Adaptable Board Computer (ABC) prototyping system (continued)

I/O Port configuration

Two ports (C and D) are implemented with 8T31 bidirectional ports and can be used for general purpose I/O. Each consists of 8 clocked latches with two sets of bidirectional inputs/outputs. Data written into one side of the port will appear inverted at the other side. One side of each port (Bus B of the 8T31) is tied to the external data bus ($\overline{\text{DBUSX}}$). The 2650 communicates with each port over this bus with one byte, non-extended I/O instructions. During 2650 activity with the ports, the ABC 1500 will provide four output strobes indicating the nature of the operation.

Table 2 Page 0 memory map

ADDRESS LINES						DECIMAL ADDRESS	ORGANIZATION	HEX ADDRESS
A14	A13	* A12	* A11	A10	** A9		▨	
0	0	X	X	1	X	8k	SECOND BLOCK RAM FIRST BLOCK RAM SECOND BLOCK RAM FIRST BLOCK RAM	1FFF
0	0	X	X	0	X	7k	PIPBUG ROM	1BFF
0	0	X	X	1	X	6k	SECOND BLOCK RAM FIRST BLOCK RAM SECOND BLOCK RAM FIRST BLOCK RAM	17FF
0	0	X	X	0	X	5k	PIPBUG ROM	13FF
0	0	X	X	1	X	4k	SECOND BLOCK RAM FIRST BLOCK RAM SECOND BLOCK RAM FIRST BLOCK RAM	0FFF
0	0	X	X	0	X	3k	PIPBUG ROM	0BFF
0	0	X	X	1	X	2k	SECOND BLOCK RAM FIRST BLOCK RAM SECOND BLOCK RAM FIRST BLOCK RAM	07FF 06FF 05FF 04FF
0	0	X	X	0	X	1k	PIPBUG ROM	03FF
▨	▨	▨	▨	▨	▨	0	▨	0000

Notes

1. * = Don't care for ROM and RAM; ** = Don't care for RAM.
2. Each block of RAM = 256 bytes.

strobe	function	strobe pulse width
WPC	write to Port C	duration of WRP
WPD	write to Port D	duration of WRP
RPC	read Port C	duration of OPREQ
RPD	read Port D	duration of OPREQ

The other side of each port (Bus A of the 8T31) is controlled by the user. Four control lines are used to read, write or three-state the buses.

control line				function
$\overline{\text{WBAD}}$	(1)	$\overline{\text{RBAD}}$	(0)	Read Port D
$\overline{\text{WBAD}}$	(0)	$\overline{\text{RBAD}}$	(0)	Write to Port D
$\overline{\text{WBAD}}$	(1)	$\overline{\text{RBAD}}$	(1)	Three-state D Bus
$\overline{\text{WBAC}}$	(1)	$\overline{\text{RBAC}}$	(0)	Read Port C
$\overline{\text{WBAC}}$	(0)	$\overline{\text{RBAC}}$	(0)	Write to Port C
$\overline{\text{WBAC}}$	(1)	$\overline{\text{RBAC}}$	(1)	Three-state C Bus

If no external logic is connected each port will be in the "read" mode ($\overline{\text{WBAX}}$ lines pulled high). The $\overline{\text{RBAX}}$ lines are tied to ground to allow read/write control of the buses with just the $\overline{\text{WBAX}}$ lines. To allow control for three-stating the buses, the following jumpers must be removed:

Line	Jumper
$\overline{\text{RBAC}}$	W19-W20
$\overline{\text{RBAD}}$	W17-W18

The clock for each port (CKC-Port C clock, CKD-Port D clock) is available at a connector pin for external control. These normally "high" lines can be pulled low to disable writing to the ports from either the 2650 or the external device.

ABC 1500 edge connector signal list

pin no.	function	pin no.	function	pin no.	function	pin no.	function
1	GND	26	$\overline{\text{INTREQ}}$	A	GND	d	OPC 3
2	GND	27	$\overline{\text{PAUSE}}$	B	GND	e	OPC 4
3	NC*	28	NC*	C	NC*	f	OPC 5
4	$\overline{\text{DBUS0}}$	29	$\overline{\text{RBAD}}$	D	OPD 0	g	OPC 6
5	$\overline{\text{DBUS1}}$	30	NC*	E	OPD 1	h	OPC 7
6	$\overline{\text{DBUS2}}$	31	$\overline{\text{RBAC}}$	F	OPD 2	j	NC*
7	$\overline{\text{DBUS3}}$	32	NC*	H	OPD 3	k	RPD
8	$\overline{\text{DBUS4}}$	33	A11	J	OPD 4	m	$\overline{\text{WBAD}}$
9	$\overline{\text{DBUS5}}$	34	A13-E/$\overline{\text{NE}}$	K	OPD 5	n	WPD
10	$\overline{\text{DBUS6}}$	35	A12	L	OPD 6	p	CKD
11	$\overline{\text{DBUS7}}$	36	A14-D/$\overline{\text{C}}$	M	OPD 7	r	NC*
12	NC*	37	A9	N	NC*	s	NC*
13	A14-D/$\overline{\text{C}}$	38	A10	P	TTY serial in +	t	NC*
14	NC*	39	A8	R	TTY serial in –	u	NC*
15	A13-E/$\overline{\text{NE}}$	40	A7	S	TTY serial out +	v	RPC
16	INTACK	41	A6	T	TTY serial out –	w	$\overline{\text{WBAC}}$
17	$\overline{\text{R}}$/W	42	A5	U	RS232 ground	x	WPC
18	WRP	43	A3	V	RS232 output	y	CKC
19	RUN/$\overline{\text{WAIT}}$	44	A0	W	NC*	z	NC*
20	OPREQ	45	A1	X	NC*	$\overline{\text{a}}$	NC*
21	M/$\overline{\text{IO}}$	46	A4	Y	RS232 input	$\overline{\text{b}}$	NC*
22	$\overline{\text{OPACK}}$	47	A2	Z	NC*	$\overline{\text{c}}$	NC*
23	CLOCK	48	+12 V	a	OPC 0	$\overline{\text{d}}$	+12 V
24	TS	49	–12 V	b	OPC 1	$\overline{\text{e}}$	–12 V
25	$\overline{\text{RESET}}$	50	+5 V	c	OPC 2	$\overline{\text{f}}$	+5 V

Adaptable Board Computer (ABC) prototyping system (continued)

ABC 1500 parts list

quantity	description
1	PC1500 printed circuit board
1	edge connector – AMP 225-804-50
1	2650 8-bit static microprocessor
1	N7402 quad 2-input NOR gate – I/O strobe logic
1	N7416 hex inverter buffer – current loop interface
1	N74123 monostable multivibrator – clock for 2650
1	N74S138 3 line to 8 line decoder – control decode
1	8T15 – EIA line driver – R232 driver
4	8T26 quad three-state driver/receiver – data and memory data buffer
2	8T31 – bit latched bidirectional I/O port
4	8T97 hex three-state driver – address and control line buffer
1	2608 static ROM (1024x8) – PIPBUG ROM – CN0035
4	2112 static RAM (256x4) – organized as 512 byte RAM
1	82S123 PROM (32x8) coded PROM CD 1500 – control decode
4	1N914 diode
1	2N2222 transistor
1	50 pF capacitor
1	300 pF capacitor
13	0,1 μF capacitor
3	4,7 μF capacitor
2	220 Ω resistor
6	1 kΩ resistor
2	2 kΩ resistor
1	3,3 kΩ resistor
8	10 kΩ resistor
1	20 kΩ resistor
1	24-pin 2608 ROM socket – Robinson-Nugent ICN 246-54

Resident Assembler Board
2650PC1600

Features

- 3-pass Resident Assembler
- 5,5k bytes assembler program
- socket for 512 bytes user defined PROM
- 2k bytes RAM
- 365 user-definable symbols
- 20 pre-defined symbols
- generation of error messages
- LIBR directive to create subroutine libraries
- compatible with PC1001, ABC1500 and DS2000
- paper tape editor facility
- single +5 V supply requirement (4 A max)
- card dimensions 20 cm by 17,5 cm with a 100-pin connector along the 20 cm dimension

The 2650PC1600 is a resident assembler to be used with the PC1001 or ABC1500 prototyping boards. It also fits into the DS2000 power supply base.

The system consists of a printed-wiring board on which 11 PROMs containing the assembler program are mounted, together with 16 RAM ICs for use as storage during program assembly. The assembler has been designed for use with paper tape and so input and output are transmitted via a teletype. Alternatively, a fast paper tape reader may be used to advantage. An extra socket has been included on the PC1600 board for PROM containing a tape-reader control program.

The PC1600 resident assembler accepts a program written in 2650 Assembly Language as input and produces a tape containing a hexadecimal translation of the program. This hexadecimal tape has a format suitable for input to the PC1001 or ABC1500 prototyping boards via the PIPBUG control program which is included on both these boards. The assembler is a three-pass type, that is the entire assembly language program is scanned three times by the assembler. On the first pass all the symbols defined by the user (up to a maximum of 365) are assigned values and stored in the RAMs on the PC1600 board and simple errors such as invalid symbols detected. During the second pass the internal logic of the program is checked and any further errors detected, the line-by-line assembly is performed and a full listing of the program, including any error messages, is printed out. On the third pass the hexadecimal tape is punched and a corresponding hexadecimal listing produced for reference.

The assembler program introduces several additional features over the cross assembler, the most important being four new error messages, 20 pre-defined symbols and a new assembler directive LIBR. This directive enables the user to assemble several tapes into one hexadecimal tape as part of the same program, this facilitates the creation of subroutine "libraries". The assembler also makes patching of a program in RAM easier by assembling the correct number of bytes for a line containing an error, so that these bytes may be altered without changing the memory locations of the rest of the bytes of the program.

PC1600 edge connector signal list

pin no.	function
1	GND
2	GND
4	DBUS0
5	DBUS1
6	DBUS2
7	DBUS3
8	DBUS4
9	DBUS5
10	DBUS6
11	DBUS7
17	R/W
18	WRP
20	OPREQ
21	M/IO
33	ABUS11
34	ABUS13
35	ABUS12
36	ABUS14
37	ABUS9
38	ABUS10
39	ABUS8
40	ABUS1
41	ABUS6
42	ABUS5
43	ABUS3
44	ABUS0
45	ABUS1
46	ABUS4
47	ABUS2
50	+5 V
A	GND
B	GND

4k Memory Card
2650PC2000

The 2650PC2000 is a 4k Memory Card designed to be compatible with the 2650 microprocessor. It is composed of 32 NMOS, 1k by 1 bit static RAMs, 21L02, and organized in four groups of one kilobyte each. Decoding is provided to select one of the four groups and also distinguish the card in multi-card configurations. In a system application utilizing up to 8 cards (32k), each card is uniquely identified by hardwired jumpers. No external decoding is required.

The decoding logic is sectioned into two blocks. The first block determines if the address identifies that card as being part of the 8k page address. (The 2650 memory scheme is organized into 4 pages of 8k each.) The second block uniquely locates 1k bytes of memory on the board in the 8k bytes of memory of the selected page. Each 1k bank is individually selected by hardwired jumpers to the decoder.

Features

- requires only single +5 V supply
- industry standard 21L02 memories
- fully decoded for 32k memory organization
- data bus buffered with three-state drivers/receivers
- accessable from microprocessor or DMA controller
- TTL compatible
- dimensions are 20 x 17,5 cm with a 50-pin edge connector along 20 cm dimension
- typical power consumption of 4,5 W

Signal definition

Memory control signals and address lines between the 2650 microprocessor and the 2650PC2000 are indicated in the block diagram. The $\overline{\text{OPEX}}$ control line is reserved for use with DMA controllers. Its function is similar to that of the OPREQ line from the 2650. When either of these lines are true and a memory operation is specified (M/$\overline{\text{IO}}$ = High) the memory card is enabled to decode address lines A0-A14. When a bank is selected, the selected card control logic block allows the read-write line ($\overline{\text{R}}$/W) and write pulse (WRP) to pass to the memory array and also enable the external data bus drivers. When the operation is complete the memory card responds with a true condition on $\overline{\text{OPACK}}$.

Jumper address decoding

Jumpers are applied to designated plated-through holes identified by a "Wn" mnemonic. To identify the card to be part of a particular page, jumper point W5 to one of the following:

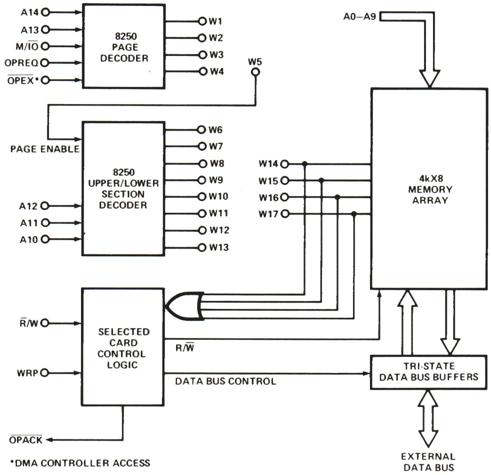
W1 for page 0
W2 for page 1
W3 for page 2
W4 for page 3

To locate each of the 1k bytes of the memory card in the selected memory page, four bank jumpers are required. The outputs of the decoder used to select one of eight 1k byte memory segments (W6-W13) must be connected to the selected 1k bytes of memory on the 2650PC2000 (W14-W17).

Factory installed jumpers allow for immediate connection to a Demo System (DS1000/2000) which has 2k of memory. These jumpers have been connected as follows:

W1 to W5 (page 0)
W8 to W14
W9 to W15
W10 to W16
W11 to W17

2650PC2000 block diagram


A14
A13
M/$\overline{\text{IO}}$
OPREQ
$\overline{\text{OPEX}}$*
8250 PAGE DECODER
W1
W2
W3
W4
W5
A0–A9
PAGE ENABLE
8250 UPPER/LOWER SECTION DECODER
W6
W7
W8
W9
W10
W11
W12
W13
A12
A11
A10
W14
W15
W16
W17
4kX8 MEMORY ARRAY
$\overline{\text{R}}$/W
WRP
SELECTED CARD CONTROL LOGIC
R/$\overline{\text{W}}$
DATA BUS CONTROL
TRI-STATE DATA BUS BUFFERS
$\overline{\text{OPACK}}$
EXTERNAL DATA BUS

*DMA CONTROLLER ACCESS

2650PC2000 edge connector

pin no.	function	pin no.	function
1,2, A, B	GROUND	34	ABUS13
4	$\overline{\text{DBUS0}}$	35	ABUS12
5	$\overline{\text{DBUS1}}$	36	ABUS14
6	$\overline{\text{DBUS2}}$	37	ABUS9
7	$\overline{\text{DBUS3}}$	38	ABUS10
8	$\overline{\text{DBUS4}}$	39	ABUS8
9	$\overline{\text{DBUS5}}$	40	ABUS7
10	$\overline{\text{DBUS6}}$	41	ABUS6
11	$\overline{\text{DBUS7}}$	42	ABUS5
17	$\overline{\text{R}}$/W	43	ABUS3
18	WRP	44	ABUS0
20	OPREQ	45	ABUS1
21	M/$\overline{\text{IO}}$	46	ABUS4
22	$\overline{\text{OPACK}}$	47	ABUS2
24	$\overline{\text{OPEX}}$	50, f	VCC +5 V
33	ABUS11		

Microprocessor Demonstration System
2650DS2000

The Demo System 2000 (2650DS2000) is a hardware base for use with the 2650 CPU printed circuit board (PC1001) and allows the exercising of this card with user defined options. When the DS2000 is combined with a CPU board (PC1001) and a teletype (TTY), the user is equipped with everything he needs to exercise any of the software or hardware features of the 2650. The DS2000 has a built-in power supply.

Features

- user-defined expansion capability from connector supplying address, data and control lines
- RS232 and TTY interface
- two extended and two non-extended I/O ports
- single step capability for program debugging
- display of address bus, data bus and the two non-extended I/O ports

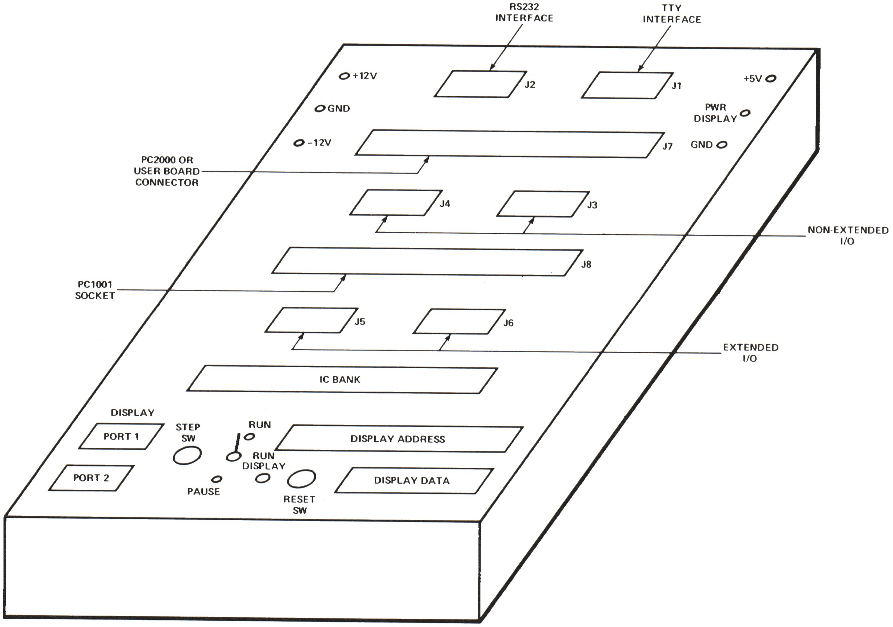
Connectors

The 2650 CPU Board (PC1001) is inserted into the J8 connector to complete the demo system. The user printed circuit board is inserted into the J7 connector. Both connectors are the same type (100 Pin Amphenol, series 225) and the numbered pins J7 and J8 have the same signals (except pin 12). The lettered pins of J7 (pins A to g) are not used.

Displays

The address and data bus led displays reflect the information on these buses during each OPREQ (beginning of an external operation). Latches store the information until another OPREQ is received. The two non-extended port displays represent data on channel C (port 2) and channel D (port 1) during the OPREQ for each I/O operation. A logic one on these displays will turn "on" the leds and a logic zero will turn them "off".

DS2000 hardware base


RS232 INTERFACE
TTY INTERFACE
+12V
J2
J1
+5V
GND
PWR DISPLAY
-12V
J7
GND
PC2000 OR USER BOARD CONNECTOR
J4
J3
NON-EXTENDED I/O
J8
PC1001 SOCKET
J5
J6
EXTENDED I/O
IC BANK
DISPLAY
PORT 1
STEP SW
RUN
DISPLAY ADDRESS
RUN DISPLAY
PORT 2
PAUSE
DISPLAY DATA
RESET SW

Controls

The pause and step logic allows one instruction to be executed at a time by pushing the 'step' button when the Run/Pause switch is in the pause position. In this mode the Run/$\overline{\text{Wait}}$ display led will go off. The reset switch will reset the display latches and place all zeros in the 2650 instruction address register.

Connections to sockets J7 and J8

pin no.	function (J7 and J8)	pin no.	function (J7 and J8)	pin no.	function (J8 only)*	pin no.	function (J8 only)*
1	GND	26	$\overline{\text{INTREQ}}$	A	GND	d	OPC 3
2	GND	27	$\overline{\text{PAUSE}}$	B	GND	e	OPC 4
3	NC**	28	NC	C	NC	f	OPC 5
4	$\overline{\text{DBUS0}}$	29	NC	D	OPD 0	g	OPC 6
5	$\overline{\text{DBUS1}}$	30	NC	E	OPD 1	h	OPC 7
6	$\overline{\text{DBUS2}}$	31	NC	F	OPD 2	j	EIPC
7	$\overline{\text{DBUS3}}$	32	NC	H	OPD 3	k	IPD 0
8	$\overline{\text{DBUS4}}$	33	ABUS 11	J	OPD 4	m	IPD 1
9	$\overline{\text{DBUS5}}$	34	ABUS 13	K	OPD 5	n	IPD 2
10	$\overline{\text{DBUS6}}$	35	ABUS 12	L	OPD 6	p	IPD 3
11	$\overline{\text{DBUS7}}$	36	ABUS 14	M	OPD 7	r	IPD 4
12*	EIPD	37	ABUS 9	N	COPD	s	IPD 5
13	D/$\overline{\text{C}}$	38	ABUS 10	P	TTY serial in +	t	IPD 6
14	$\overline{\text{DMA}}$	39	ABUS 8	R	TTY serial in –	u	IPD 7
15	E/$\overline{\text{NE}}$	40	ABUS 7	S	TTY serial out +	v	IPC 0
16	INTACK	41	ABUS 6	T	TTY serial out –	w	IPC 1
17	$\overline{\text{R}}$/W	42	ABUS 5	U	RS232 ground	x	IPC 2
18	WRP	43	ABUS 3	V	RS232 output	y	IPC 3
19	RUN/$\overline{\text{WAIT}}$	44	ABUS 0	W	TTY tape reader out +	z	IPC 4
20	OPREQ	45	ABUS 1	X	TTY tape reader out –	$\overline{\text{a}}$	IPC 5
21	M/$\overline{\text{IO}}$	46	ABUS 4	Y	RS232 input	$\overline{\text{b}}$	IPC 6
22	$\overline{\text{OPACK}}$	47	ABUS 2	Z	COPC	$\overline{\text{c}}$	IPC 7
23	CLOCK	48	+12 V	a	OPC 0	$\overline{\text{d}}$	+12 V
24	$\overline{\text{OPEX}}$	49	–12 V	b	OPC 1	$\overline{\text{e}}$	–12 V
25	$\overline{\text{RESET}}$	50	+5 V	c	OPC 2	$\overline{\text{g}}$	+5 V

* J7 has no connections to these pins.
** NC = No Connection.

Microprocessor Demonstration System (continued)

Extended I/O DIL sockets

pin no.	function J5	function J6
1	$\overline{\mathrm{DBUS0}}$	ABUS 0
2	$\overline{\mathrm{DBUS1}}$	ABUS 1
3	$\overline{\mathrm{DBUS2}}$	ABUS 2
4	$\overline{\mathrm{DBUS3}}$	ABUS 3
5	$\overline{\mathrm{DBUS4}}$	ABUS 4
6	$\overline{\mathrm{DBUS5}}$	ABUS 5
7	$\overline{\mathrm{DBUS6}}$	ABUS 6
8	$\overline{\mathrm{DBUS7}}$	ABUS 7
9	$\overline{\mathrm{OPACK}}$	ABUS 8
10	$\mathrm{M}/\overline{\mathrm{IO}}$	ABUS 9
11	OPREQ	ABUS 10
12	$\mathrm{RUN}/\overline{\mathrm{WAIT}}$	ABUS 11
13	WRP	ABUS 12
14	$\overline{\mathrm{R}}/\mathrm{W}$	ABUS 13
15	INTACK	ABUS 14
16	$\mathrm{E}/\overline{\mathrm{NE}}$	$\overline{\mathrm{PAUSE}}$
17	$\overline{\mathrm{DMA}}$	$\overline{\mathrm{INTREQ}}$
18	$\mathrm{D}/\overline{\mathrm{C}}$	CLOCK

Non-extended I/O DIL sockets

pin no	function J3	function J4
1	(Output Port C) 0	(Output Port D) 0
2	OPC 1	OPD 1
3	OPC 2	OPD 2
4	OPC 3	OPD 3
5	OPC 4	OPD 4
6	OPC 5	OPD 5
7	OPC 6	OPD 6
8	OPC 7	OPD 7
9	Clock Output Port C	Clock Output Port D
10	Enable Input Port C	Enable Input Port D
11	(Input Port C) 7	(Input Port D) 7
12	IPC 6	IPD 6
13	IPC 5	IPD 5
14	IPC 4	IPD 4
15	IPC 3	IPD 3
16	IPC 2	IPD 2
17	IPC 1	IPD 1
18	IPC 0	IPD 0

TTY interface DIL socket

pin no.	function J1
1	TTY serial in +
2	TTY serial in –
8	TTY tape reader out –
9	TTY tape reader out +
13	TTL serial out –
14	TTL serial out +

RS232 interface connector

pin no.	function J2
1	RS232 ground
2	RS232 input
3	RS232 output
5	jumper
6	jumper
7	RS232 ground
8	jumper
20	jumper

Intelligent Typewriter Controller
2650PC3000

The 2650PC3000 is a basic text generating system requiring only six integrated circuits including one 2650 microprocessor. The serial communication link between the 2650 and the users terminal is accomplished with the flag and sense lines on the microprocessor. The 2650PC3000 is used to control the storage of characters entered from a terminal with either a current loop or voltage swing capability (±7,5 V min).

Control Characters allow the text to be printed out on the terminal with the capability for inserting unique characters at locations identified during text generation. When the text is printed out the entire text will be output unless a control character is detected. The microprocessor then stops the print-out and the operator enters the desired unique information. Another control character is then given to continue printing the text until all characters stored in memory are printed or until another stop character is detected. The stop character is recorded in memory just like any other character; however, it is not printed during text print-out.

Additional control characters allow for the erasure of the previous character typed or the erasure of the entire memory.

Features

- total of six IC packages
- operates at +5 V at a max of 500 mA
- interface to either current loop or device capable of sending and receiving a minimum voltage swing of ±7,5 V referenced to signal ground
- 250 character storage capability
- card size less than 7,5 x 10 cm with four screwed-on stand-offs at corners
- 1 MHz clock implemented with 74123 one-shot
- variable baud rate between 110 and 300 baud by trimmer pot adjustment of clock
- PROM mounted in 24-pin socket
- card edge connector supplied with each card
- inputs provided for an external system reset

Parts descriptions

2650	8-bit TTL compatible N-Channel Microprocessor incorporating a serial I/O Port. (See 2650 Hardware Specification Manual for complete description – 2650BM1000.)
2606	1024-bit static MOS, TTL compatible RAM memory organized as 256 words by 4 bits/word
82S115	4096-bit Bipolar TTL compatible PROM organized as 512 words by 8 bits/word
N7426	Quad 2-input high voltage NAND gate with open collector capable of driving voltage and current loop interfaces (20 mA max)
74123	Dual retriggerable monostable multivibrator with clear configured as a clock for 2650
Potentiometer	Helipot series 91C 50 kΩ, 9,5 mm cermet trimming potentiometer
PC edge connector	Amphenol – 225-21021-401-117 Cinch – 251-10-30-160

Miscellaneous components consist of eleven ¼ W and two ½ W resistors, and two mica, one ceramic and one tantalum capacitor.

The following are required to make the board functional but are not supplied with the card:

RS232 type connector for voltage swing interface: DB25P or DB25S

Reset switch – (normally open, connected to +5 V)

Power supplies: +5 V
±15 V

Intelligent Typewriter Controller (continued)

Terminal interface

voltage mode terminal connection

The voltage mode interface is very similar to the standard RS232 interface except that the "signal" ground cannot be connected to "protective" ground. When a Cinch type 25-pin connector (DB25P or DB25S) is used on an RS232 compatible terminal, the PC3000 should be connected as follows:

DB25P (DB25S) pin no.	PC3000 edge connector pin no.	PC3000 signal name
1	no connection	–
3	6	VS out +
2	J	VS in +
7	K	VS out – (signal GND)
5, 6, 8, 20	connect together	–

on card – jumper point A to C
and point D to E.

current loop terminal connection

When a terminal is used that employs current loop transmission techniques the four wires from the terminal should be connected to the corresponding four pins on the PC3000 card: TTY out +, TTY out –, TTY in +, and TTY in–.

on card – jumper point A to B
and point D to F.

PC3000 command summary

key	function
Rubout (delete)	Erase last character in memory and echo the erased character. Additional preceding characters can be erased by continuing to depress the delete key.
Control and E	Erase entire memory.
Control and B	Used to indicate beginning of inserted message. Is not printed but stored in memory. Stops print-out when read from memory. Required once from each unique information entry.
Control and C	Continues print-out of memory after entry of unique information.
Control and P	Prints out contents of terminal memory.
Control and R	Software reset.

Note:
Bell will ring if any of the following are true

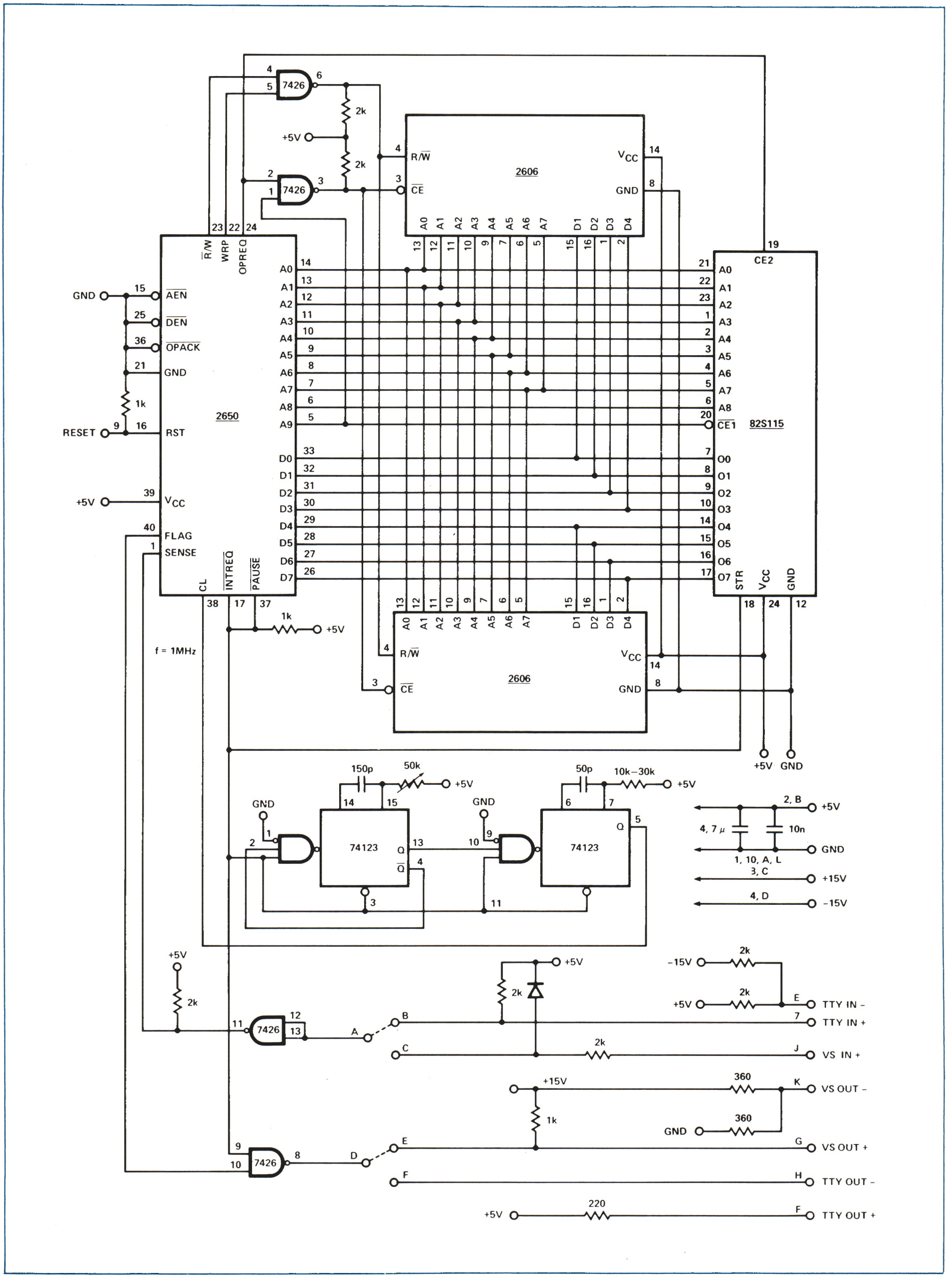
1. Entering more than 250 characters in memory.
2. Requesting print-out of an empty buffer.
3. Attempting to delete more characters than there are in memory.

PC3000 connector pin assignment

pin no.	function	pin no.	function
1	GND	A	GND
2	+5	B	+5
3	+15	C	+15 V
4	–15	D	–15
5	–	E	TTY in –
6	VS out +	F	TTY out +
7	TTY in +	H	TTY out –
8	–	J	VS in +
9	RESET	K	VS out – (Signal Ground)
10	GND	L	GND

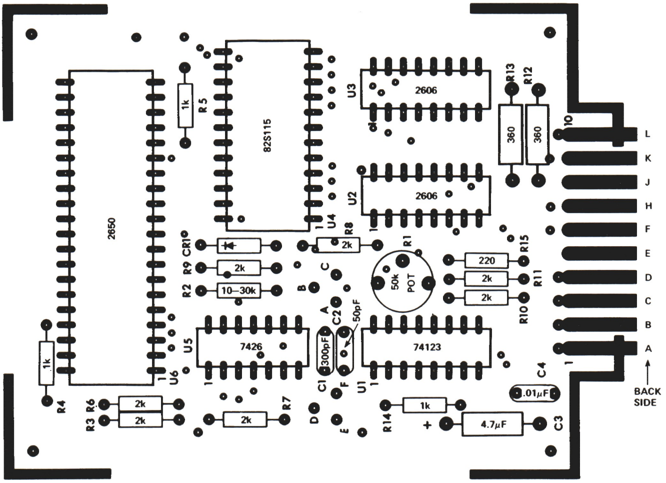
VS – Voltage Swing

Intelligent typewriter controller

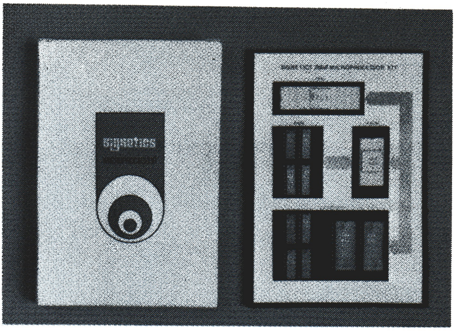

7426
2k
+5V
2606
R/W
CE
VCC
GND
A0 A1 A2 A3 A4 A5 A6 A7
D1 D2 D3 D4
2650
R/W
WRP
OPREQ
AEN
DEN
OPACK
GND
RST
RESET
VCC
FLAG
SENSE
CL
INTREQ
PAUSE
A0 A1 A2 A3 A4 A5 A6 A7 A8 A9
D0 D1 D2 D3 D4 D5 D6 D7
1k
f = 1MHz
82S115
CE2
CE1
A0 A1 A2 A3 A4 A5 A6 A7 A8
O0 O1 O2 O3 O4 O5 O6 O7
STR
VCC
GND
+5V GND
150p
50k
50p
10k–30k
74123
Q
Q
2, B
4, 7 µ
10n
1, 10, A, L
3, C
4, D
+15V
−15V
TTY IN −
TTY IN +
VS IN +
VS OUT −
VS OUT +
TTY OUT −
TTY OUT +
360
220

Intelligent Typewriter Controller (continued)

Intelligent typewriter controller board layout


2650
1k
R4
R3 R6
2k
2k
1k
R5
82S115
U3
2606
U2
2606
U4
R13
R12
360
360
10
L
K
J
H
F
E
D
C
B
A
BACK SIDE
1
CR1
R9
2k
R2
10–30k
R8
2k
R1
50k POT
220
2k
2k
R15
R11
R10
C
B
A
C2
50pF
U5
7426
300pF
C1
F
U1
74123
U6
R7
2k
D
E
R14
1k
+
4.7μF
C3
C4
.01μF

Microprocessor Prototyping Kit
2650KT9100



The KT9100 kit contains a 2650 microprocessor and enough chips to implement a small development system. Since the interface requirements of the 2650 are completely TTL compatible, no attempt has been made to limit the user's flexibility by dictating a fixed logic configuration. There is complete freedom in using standard SSI or MSI logic to adapt the microprocessor to the memory, I/O devices, or clock.

Several simple system examples are presented to enable quick set up and evaluation. Other configurations to adapt to individual requirements should become evident from these examples.

Parts descriptions

2112: The 2112 is a static 1024-bit RAM organized as 256 words by 4 Bits/Word. It is manufactured with n-channel, silicon gate, MOS technology and achieves an access time of less than 800 ns. No clocks are required, and the chip is powered from a single 5 V source.

82S115I: The 82S115I is a 4096-bit Schottky-Clamped, bipolar PROM incorporating on-chip data output registers. It is field-programmable and fully TTL compatible with on-chip decoding and two chip enable inputs for easy memory expansion. Inputs to the device are pnp transistors with a maximum current requirement of 100 μA.

8T31: The 8T31 is an 8-bit Bidirectional I/O Port designed to function as a general purpose I/O interface element. It consists of 8 clocked latches with two sets of bidirectional Inputs/Outputs allowing master control from either the microprocessor or from the I/O device.

8T26B: The 8T26B consists of four pairs of inverting three-state logic elements configured as Quad Bus Drivers/Receivers with separate buffered receiver enable and driver enable lines. Both the driver and receiver gates have three-state outputs and low-current pnp inputs.

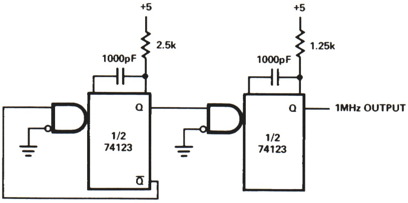
Circuit examples

Two circuit configurations are presented to indicate a possible program checkout approach. The first allows the use of RAM for program debugging. The second figure represents a possible final system configuration with the program fixed in PROM. Both circuits use the 8T26s as bus buffers.

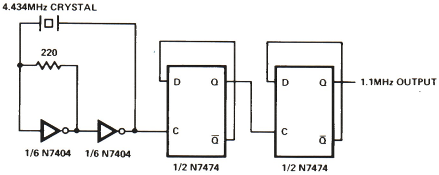
Parts list

part no.	qty	description
2650	1	CPU
2112	4	256 x 4 RAM
82S115I	1	4k PROM (Unprogrammed) 512 x 8
8T31I	2	8-bit Bidirectional I/O Port
8T26B	4	Quad Bus DR/REC

One-shot clock oscillator circuit

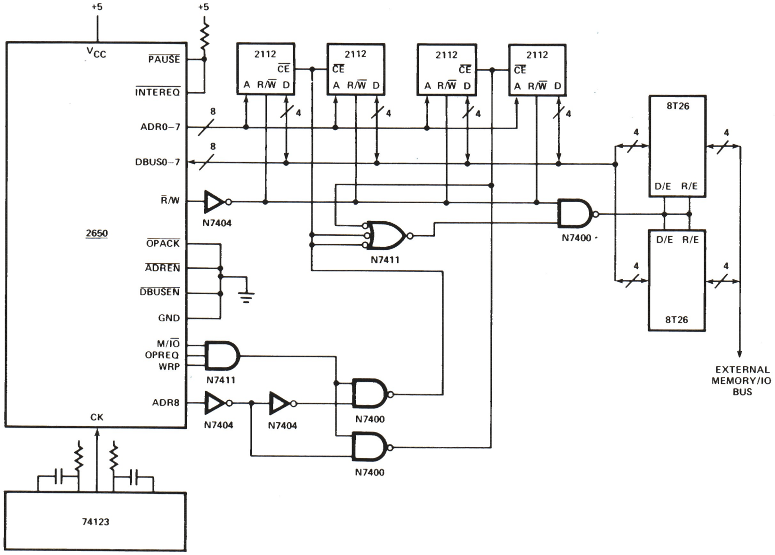


Crystal oscillator circuit

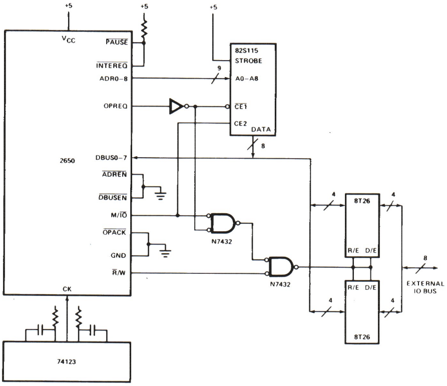


Microprocessor Prototyping Kit (continued)

Example of initial program checkout configuration


+5
+5
VCC
PAUSE
INTEREQ
ADR0–7
DBUS0–7
R/W
2650
OPACK
ADREN
DBUSEN
GND
M/IO
OPREQ
WRP
ADR8
CK
8
8
2112
CE
A R/W D
4
N7404
N7411
N7400
N7404
N7404
N7400
N7400
N7411
8T26
D/E R/E
EXTERNAL MEMORY/IO BUS
74123

Finalized configuration with program fixed in PROM


+5
+5
+5
VCC
PAUSE
INTEREQ
ADR0–8
OPREQ
2650
DBUS0–7
ADREN
DBUSEN
M/IO
OPACK
GND
R/W
CK
82S115
STROBE
A0–A8
CE1
CE2
DATA
9
8
N7432
N7432
8T26
R/E D/E
4
8
EXTERNAL IO BUS
74123

2650 Assembler Version 3.2
2650AS1000/1100

The 2650 assembly language (PIPHASM) is a symbolic language designed specifically to facilitate the writing of programs for the 2650 microprocessor.

The AS1000 is for 32-bit or larger machines and the AS1100 is for 16-bit machines.

The 2650 assembler is a program which accepts symbolic source code as input and produces a listing and/or an object module "Hexadecimal" format compatible to the two tape punching programs PIPHTAP (for acceptance by PIPBUG), PIPSTAP (for PROMs) and also to the simulator, PIPSIM.

The assembler is written in standard Fortran IV and is approximately 1 250 Fortran card images in length. It is modular and may be executed in an overlay mode should memory restrictions make that necessary. It operates in a two-pass mode to build a symbol table, to issue helpful error messages, produce an easily readable program listing and output a computer-readable object module. This version of the assembler compiles into a 12k word load module on the PDP-11/40 (16-bit words) and executes under DOS (8k) within a 28k memory.

Availability

The 2650 assembler is available on both NCSS and GE timeshare. It is also available from Signetics on 9-track magnetic tape written in EBCDIC in 80-character unblocked records at a density of 800 bpi.

Features

- forward references
- pseudo-ops to aid programming
- self-defining constants
- symbolic machine operation codes
- free format source code
- syntax error checking
- symbolic address assignment and references
- data creation statements
- storage reservation statements
- assembly listing control statements
- addresses can be generated as constants
- character codes may be specified as ASCII or EBCDIC
- comments and remarks may be encoded for documentation

Language requirements

I. Input requirements

Input to the assembler consists of a sequence of characters combined to form assembly language elements. These language elements include symbols, instruction mnemonics, constants and expressions which make up the individual program statements that comprise a source program.

A. Characters

alphabetic:	A-Z
numeric	0-9
special characters	blank
	(left parenthesis
	) right parenthesis
	+ add or positive value
	— subtract or negative value
	* asterisk
	' single quote
	, comma
	/ slash
	$ dollar sign
	< less than sign
	> greater than sign

B. Symbols

Symbols are formed from combination of characters. Symbols provide a convenient means of identifying program elements so they can be referenced by other elements.

C. Constants

A constant is a self-defining language element. Unlike a symbol, the value of a constant is its own "face" value and is invariant. Internal numbers are represented in 2s complement notation. There are two forms in which constants may be written: the Self-Defining Constant and the General Constant.

Self-Defining Constant

The self-defining constant is a form of constant which is written directly in an instruction and defines a decimal value.

General Constant

The general constant is also written directly in an instruction, but the interpretation of its value is dictated by a code character and delimited by quotation marks. Its form can be binary, octal, decimal, hexadecimal, EBCDIC or ASCII.

D. Expressions

An expression is an assembly language element that represents a value. It consists of a single term or combination of terms separated by arithmetic operators. A term may be a valid symbolic reference, a self-defining constant or a general constant.

2650 Assembler Version 3.2 (continued)

II. Fields

A statement prepared for processing by the assembler is logically divided into four fields, as indicated below. They are free form and are separated by at least one blank character. The name must begin in logical column 1.

Label	Operation	Operand	Comments
name	opcode	operand(s)	

Where:

Label field	contains an optional label which the assembler will assign as the symbolic address of the first byte of the instruction.
Operation field	contains any of the 2650 processor mnemonic operation codes or any assembler Directive. This field may include an expression which specifies a register or value as required by the instruction. All symbols used in this field must have been previously defined, i.e. no symbolic forward references are allowed.
Operand field	contains one or more operand elements such as indirect address indicator, operand expression, index register specification, auto-increment/auto-decrement indicator, constant specification, etc. depending on the requirements of the particular instruction.
Comments field	any characters following the operand field will be reproduced in the assembly listing without processing. The Comments Field must be separated from the argument field by at least one blank.

III. Directives

There are eleven directives which the assembler will recognize. These assembler directives, although written much like processor instructions, are simply commands to the assembler instead of to the processor. They direct the assembler to perform specific tasks during the assembly process, but have no meaning to the 2650 processor. These assembler directives are:

ORG	Set location counter
EQU	Specify a symbol equivalence
ACON	Define address constant
DATA	Defines memory data
RES	Reserve memory storage
END	End of assembly
EJE	Eject the listing page
PRT	Printer control
SPC	Space control
TITL	Title
PCM	Punch control

2650 Simulator Version 1.2
2650SM1000/1100

The 2650 Simulator (PIPSIM) is a Fortran IV program which allows a user to simulate the execution of his program without utilizing the 2650 processor. The simulator executes the 2650 program via host computer software by maintaining its own internal Fortran storage registers to describe the 2650 program, the microprocessor registers, the ROM/RAM memory configuration, and the input data to be read dynamically from I/O devices. Inputs to the simulator are the object module (or the 2650 program in object format) produced by the 2650 assembler and a deck of user commands. The simulator can accommodate an object module of up to 8192 Bytes.

The output consists of a listing of the user's commands and a print out of both static and dynamic information as requested by the commands. The user may request traces of the processor status, dumps of the contents of memory, and recording of program timing statistics. Multiple simulations of the same program with different parameters may be executed during one simulation run.

The SM1000 is configured to operate on 32-bit or larger machines and executes under DOS (8k) within a 28k memory. The SM1100 is configured for 16-bit machines and compiles into a 16k word load module on a PDP-11/40.

Availability

The 2650 Simulator is available on both NCSS and GE timeshare. It is also available from Signetics on a 9-track magnetic tape written in EBCDIC in 80-character unblocked records at a density of 800 bpi.

Features

- cycle counter for timing estimates
- instruction fetch break points
- operand fetch break points
- trace facilities
- snapshot dumps
- patching facility
- statistical information generated
- easy-to-use command language
- optionally selected start and end addresses
- simulated registers may be displayed while the simulation program is executed
- simulated registers may be altered while the program is executing
- maintains a 2k cell (easily modified to 8k) to simulate a read/write RAM
- capability exists for configuring parts of simulator memory to look like ROM
- incorporates a 200-byte first in, first out (FIFO) buffer to store the data read from a simulated input device
- establishes initial program conditions
- monitors execution sequences

User commands

Commands specify how the program is to run and what data is to be recorded. The simulator accepts information in card image form. The entire card is read in Fortran "A" format, and one command must be complete on one card. Comments may appear in any order within a command set.

The basic manual set (2650BM1000) contains a complete description of the user commands and the general operation of the simulator.

2650 Simulator Version 1.2 (continued)

command name	parameters	description
DUMP	LOC, FWA-LWA(;....;LOC, FWA-LWA)	Display the area of memory, FWA-LWA, whenever the instruction at LOC executes.
REND	NONE	Execute the last simulation and terminate the entire run.
INPUT	VALUE (;....;VALUE)	Define the data to be read by simulated I/O instructions.
INSTR.	LOC(;....;LOC)	Display the processor state whenever the instruction at LOC executes.
LIMIT	NO	Specify the total number of instructions executed.
PATCH	LOC, VALUE(;....;LOC,VALUE)	Initialize each memory location, LOC, to VALUE
REFER.	LOC(;....;LOC)	Display the processor state whenever the instruction at LOC is referenced by another instruction.
SETP.	LOC(,PSL=VALUE), (,PSU=VALUE)	Set the program status byte (lower and/or upper) to VALUE whenever the instruction at LOC executes.
SETR.	LOC (9, RO=VALUE)...(R6=VALUE)	Set the general purpose registers to VALUE whenever the instruction at LOC executes.
SROM	FWA-LWA	Specify the boundaries of Read-Only Memory.
START	LOC	Start the simulated program execution at LOC.
STAT	None	Display instruction statistics at end of program execution.
STOP.	LOC(;....;LOC)	Terminate the program execution when the instruction at LOC executes.
TEND	None	Execute the last simulation and prepare to read the User Commands for the next simulation.
TRACE.	FWA-LWA(;....;FWA-LWA)	Display the processor state whenever an instruction executes, which lies within the area of memory, FWA-LWA.

Higher Level Language (PLμS)
2650PL1000

The higher level language is designed for use with the 2650 microprocessor. This language allows the programmer to reduce programming effort while retaining the control and efficiency of assembly language. It is written in ANSI standard Fortran IV and will execute on most machines without alteration. Programs written in this language tend to be self-documenting and are easily altered.

The higher level language is a sequence of "Declarations" and "Executable Statements".

The declarations allow the programmer to control allocation of storage, define simple textual substitutions (Macros), and define procedures. The language is "Block Structured": procedures may contain further declarations which control storage allocation and define other procedures.

The procedure definition facility of the language allows modular programming: a program can be divided into sections (e.g. teletype input, conversion from binary to decimal forms, and printing output messages). Each of these sections is written as a language procedure. Such procedures are conceptually simple, easy to formulate and debug and easily incorporated into a large program. They may form a basis for a procedure library, if a family of similar programs is being developed. Procedures may be individually compiled.

The language handles two kinds of data, its two basic "Data Types": byte and address. A byte variable or constant is one that can be represented as an 8-bit quantity; an address variable or constant is a 16-bit or double-byte quantity. The programmer can declare variable names to represent byte or address values. One can also declare vectors (or arrays) or type byte or address.

In general, executable statements specify the computational processes that are to take place. To achieve this, arithmetic, logical (Boolean), and comparison (relational) operators are defined for variables and constants of both types (BYTE and ADDRESS). These operators and operands are combined to form EXPRESSIONS, which resemble those of elementary algebra. Expressions are a major component of language statements.

A simple statement form is the assignment statement, which computes a result and stores it in a memory location defined by a variable name. Other statements in the language perform conditional tests and branching, loop control, and procedure invocation with parameter passing. The flow of program execution is specified by means of powerful control structures that take advantage of the block-structured nature of the language. Input and output statements read and write 8-bit values from and to input and output ports. Procedures can be defined which use these basic input and output statements to perform more complicated I/O operations.

A method of automatic text-substitution (more specifically, a "compile-time macro facility") is also provided. A programmer can declare a symbolic name to be completely equivalent to an arbitrary sequence of characters. As each occurrence of the name is encountered by the compiler, the declared character sequence is substituted, so the compiler actually processes the substituted character string instead of the symbolic name.

The compiler supports compile time expression evaluation and conditional compilation which allows selective compilation of code depending on an input parameter at compile time.

The language generates absolute and/or relocatable code. The relocatable modules may be linked by a powerful linkage editor at load time.

Additionally the language contains all machine independent features of the PL/M language as a subset, thereby enhancing portability of programs.

Availability

The higher level language is available on NCSS timeshare. It is also available from Signetics on magnetic tape for 16 and 32-bit machines.

Features

- written in free-form
- adaptable to both 16 and 32-bit machines
- block structured
- employs procedure calls
- byte and address data elements
- based variables
- in-line assembly language
- Macro capability
- generates relocatable code supported by a relocating loader
- includes PL/M as a subset
- allows separate compilation of program modules
- has improved control structure over PL/M
- conditional compilation
- compile time expression evaluation

Microcomputer Prototype Development System TWIN

The Microprocessor Prototype Development System is a modular system designed to support development and implementation of 2650 microcomputer systems.

A typical system consists of three hardware elements: a Prototype Development Computer (PDC), a floppy disk storage subsystem, and a system console (typically an ASR33 teletype). The PDC includes an integral MOS and bipolar PROM programmer and an in-circuit emulation/hardware debug facility. A wide range of PDC cards and system peripherals are available.

System software includes an Operating System, File Management, Debug Software, Text Editor, and 2650 Resident Assembler. These programs provide the user with the tools to perform his software development easily and quickly. These software capabilities, together with the capacity and performance of the floppy disk subsystem, and the in-circuit emulation/hardware debug capability significantly reduce the time and cost of a microcomputer system development project.

The Microprocessor Prototype Development System introduces a unique new Multiprocessor architecture for prototyping systems. This architecture provides users with the benefits of maximum availability of common (user) memory space and a Master processor/Operating System that is isolated and independent from the user system in the in-circuit emulation/hardware debug mode.

The Microprocessor Prototype Development System will have a long life cycle, since it is designed with the capability of supporting future microprocessors, additional peripherals and expanded software support and hardware debug capabilities.

Hardware features

Modular microprocessor prototype development system to support development, implementation and check out of 2650 microcomputer systems.

Powerful new Multiprocessor architecture provides maximum memory space to user and a protected environment for the Master processor/Operating System at all times.

The 2650 microprocessor –5 V only, fully TTL compatible, 2,4 μs cycle time, easy-to-learn instruction set – is used for the Master and Slave microprocessors.

Hardware interfaces and software drivers provided for floppy disk storage subsystem, TTY, CRT terminal, paper tape reader, line printer and EIA RS232 terminals.

In-circuit emulation/hardware debug and powerful debug software provides extensive emulation and diagnostic facilities for the user system.

Integral MOS and bipolar PROM programmers.

User/Common memory of 16k bytes, expandable to 64k bytes.

Two universal bus structures with multiprocessor and DMA capabilities.

Eight-level maskable priority interrupt system available to the user.

Software features

System software provided with the Prototype Development System includes the Signetics Disk Operating System (SDOS), text editor, debug package, 2650 assembler and linkage editor.

The Signetics Disk Operating System (SDOS) provides complete control over operation of all portions of the Prototype Development System. All functions relating to file handling, loading and execution are included, as well as provision for invoking the debug system and PROM programming functions.

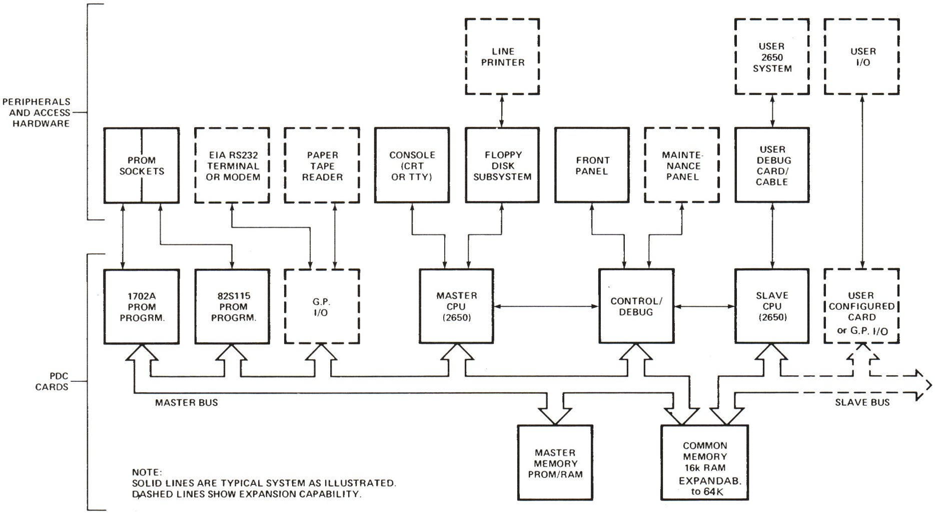
The SDOS software has been designed to allow the user to create, edit, and assemble files; obtain object and listing outputs; load and execute programs; and through the debug system, check out programs in a most efficient manner.

SDOS provides a powerful procedure capability which gives the user the capability of creating powerful and customized operating system commands dynamically.

Programs may be read and written in either hexadecimal or SMS (Signetics Memory Services) format for (P)ROM programming.

The SDOS software provides a flexible input/output system which is organized through logical channels allowing the user to dynamically assign any logical channel to any physical device or file within the system. Thus, system I/O devices may be dynamically assigned using SDOS commands either from the console or from within a user's program.

Typical system


PERIPHERALS AND ACCESS HARDWARE
PDC CARDS
LINE PRINTER
USER 2650 SYSTEM
USER I/O
PROM SOCKETS
EIA RS232 TERMINAL OR MODEM
PAPER TAPE READER
CONSOLE (CRT OR TTY)
FLOPPY DISK SUBSYSTEM
FRONT PANEL
MAINTENANCE PANEL
USER DEBUG CARD/ CABLE
1702A PROM PROGRM.
82S115 PROM PROGRM.
G.P. I/O
MASTER CPU (2650)
CONTROL/ DEBUG
SLAVE CPU (2650)
USER CONFIGURED CARD or G.P. I/O
MASTER BUS
SLAVE BUS
MASTER MEMORY PROM/RAM
COMMON MEMORY 16k RAM EXPANDAB. to 64K

NOTE:
SOLID LINES ARE TYPICAL SYSTEM AS ILLUSTRATED.
DASHED LINES SHOW EXPANSION CAPABILITY.

SDOS assumes a dual CPU environment with one CPU designated as a master and the other as a slave. SDOS resides in a dedicated memory consisting of ¼k PROM and 16k of RAM running under the master CPU.

SDOS will control a multidrive floppy disk subsystem (up to 8 drives), a line printer, a high speed paper tape reader and an ASR-33TTY compatible console. Drivers are provided within SDOS for these I/O devices. In addition, the user may write his own driver for other peripheral devices and easily link them into the SDOS system.

The Prototype Development System Resident Assembler translates symbolic 2650 assembly language instructions into appropriate machine language code.

Microcomputer Prototype Development System (continued)

The Assembler produces absolute object code. The absolute object code produced is in hexadecimal format which may be converted by an SDOS command to SMS format for PROM or ROM programming.

The Text Editor is a comprehensive software package which allows the user to enter and modify text files. The Text Editor is line oriented and accepts inputs from an input file, performs modifications in a work space and outputs the revised text to an output file.

The Debug System is a software program which will provide the user with run-time program debug capabilities within a hardware environment. It utilizes special hardware features built into the program development system to control the execution of the user's program. User programs operating under the debug system will have dynamic program trace, breakpoint capabilities, memory modification capabilities, and status reporting on the memory, program, and internal processor status.

All of the above-described software will be supplied in object format on diskette and is provided with each Prototype Development System.

PDC cards

Master CPU
System Crystal Clock
Master 2650
UART/TTY Interface
Real Time Clock
Disk/Paper tape Port

Control/debug
Debug Logic
Master/Slave Interaction
Interrupt Logic
Front Panel Interface

Slave CPU
Slave 2650
User Cable Interface

Master memory
4k-Byte Static NMOS RAM
2k-Byte 1702A Erasable PROM

Common memory – 4k RAM
4k-Byte Static NMOS RAM

Common memory – 16k RAM
16k-Byte Dynamic NMOS RAM

General purpose I/O
EIA Interface
Four Output Ports
Four Input Ports
8 Interrupt Lines

1702 PROM programmer

82S115 PROM programmer

User configurable card
For interfacing directly with users own I/O devices.

Extender card

Peripherals

Floppy disk subsystem
Expandable to 8 drives

Line printer (optional)

High speed paper tape reader (optional)

Teletype (optional)

CRT terminal (optional)

A.C. power requirements
50 Hz or 60 Hz, 115/230 VAC

process levels

The Signetics Mil 38510/883 program is organized to provide a broad selection of processing options, structured around the most commonly requested customer flows. The program is designed to provide our customers:

- Standard processing flows to help minimize the need for custom specs.
- Cost savings realized by using standard processing flows in lieu of custom flows.
- Better delivery lead times by minimizing spec negotiation time, plus allows customers to buy product off-the-shelf or in various stages of production rather than waiting for devices started specifically to custom specs.

The following explains the different processing options available to you. Special device marking clearly distinguishes the type of screening performed. Refer to tables.

JAN qualified (JB)

JAN qualified product is designed to give you the optimum in quality and reliability. The JAN processing level is offered as the result of the government's product standardization programs, and is monitored by the Defense Electronic Supply Center (DESC), through the use of industry-wide procedures and specifications.

JAN qualified products are manufactured, processed and tested in a government certified facility to Mil-M 38510, and appropriate device slash sheet specifications. Design documentation, lot sampling plans, electrical test data and qualification data for each specific part type has been approved by the Defense Electronic Supply Center (DESC) and products appear on the DESC qualified products list (QPL-38510).

Group B testing, per Mil-Std-883 method 5005, is performed on each six weeks of production on each slash sheet for each package type. Group C, per Mil-Std-883 method 5005, is performed every ninety days for each microcircuit group. Group D testing, per Mil-Std-883 method 5005, is performed every six months for each package type.

In addition to the common specs used throughout the industry for processing and testing, JAN qualified products also possess a requirement for a standard marking used throughout the IC industry.

/883B(RB)

Processing to this option is ideal when no JAN slash sheets are released on devices required. Product is processed to Mil-Std-883 method 5004, and is 100% electrically tested to industry data sheets.

Group B, C and D testing is performed per Mil-Std-883 method 5005, in accordance with the Signetics military generic data program. Offshore assembly is allowed.

MIL temp/883C (S/RC)

If you need a Military temperature range device, but do not require all the high reliability screening performed in the other processing options, our Mil-Temp. product is ideal. Mil-Temp. parts are the standard full Mil-Temperature range product guaranteed to a 1% AQL to the Signetics data sheet parameters.

military generic data

Signetics has a new program for those customers who require quality conformance data on their products. This program allows our customers to obtain reliability information without the necessity of running Groups B, C and D inspections for their particular purchase order. It provides for the customer something that has not been readily available before in the semiconductor industry in that all military generic data is controlled and audited by both government inspection in the case of JAN data and Signetics quality assurance.

Signetics military generic data is compiled by the Military Products Division based on data from:

1. JAN quality conformance lots.
2. Data generated by quality conformance lots run for other reliability programs. Refer to table.

A military generic family is defined as consisting of die function and package type families.

- Allows our customers to qualify Signetics products based on existing quality conformance data performed at Signetics.
- Allows our customers to reduce costs and improve deliveries.
- Provides assurance that all Signetics die function families and packages meet Mil-M-38510 and customer reliability requirements.
- Provides an attributes summary to the customer backed by lot identity and traceability.

Definition and qualifying manufacturing periods for generic data

qualified sub-groups	qualifies	option 1	option 2
A	Electrical Test	Group A is performed on each lot or sublot of Signetics devices.	Group A is performed on each lot or sublot of Signetics devices.
B	Package Same package construction and lead finish.	Data selected from devices manufactured within 6 weeks of the manufacturing period on the same production line through final seal.	Data selected from devices manufactured within 24 weeks of manufacturing period.
C	Die/Process Devices representing the same process families.	Data selected from representative devices from the same microcircuit group and sealed within 12 weeks of the manufacturing period.	Data selected from the representative devices from the same microcircuit group and sealed within 48 weeks of the manufacturing period.
D	Package Same package construction and lead finish.	Data selected from the devices representing the same package construction and lead finish manufactured within the 24 weeks of manufacturing period. If specific data not available, Option 2 will be supplied.	Data selected from the devices representing the same package construction and lead finish manufactured within the 52 weeks of manufacturing period.

Summary
Package availability
Products processing matrix

X = applicable

Military summary

	JB JAN qualified	RB /883	S Mil temp.
54/54H	X	X	X
54LS	X	X	X
54S	X	X	X
82/8T	X	X	X
93xx	X	X	X
96xx	—	X	X
Linear	X	X	X
Bipolar Memory	planned	X	X
Microprocessor	—	X	X

Military package availability

JAN case outline and lead finish	Signetics military package types				
	metal can		dual-in-line		
	8-pin	10-pin	14-pin	16-pin	24-pin
CB	—	—	F	—	—
EB	—	—	—	F	—
JB	—	—	—	—	I/F
DB	—	—	W	—	—
FB	—	—	—	W	—
ZC	—	—	—	—	Q
GC	T	—	—	—	—
IC	—	K	—	—	—

Military products processing matrix

process level and marking	pre-cap visual	burn-in	functional test	d.c./a.c. at 25 °C	d.c./a.c. at temp.	QPL	offshore assembly
JB JM38510/xxxxx	883B	yes	100%	100%	100%	yes	no
RB Sxxxx/883B	883B	yes	100%	100%	100%	no	yes
RC/S Sxxxx/883C	883B	no	100%	100% d.c. sample a.c.	sample d.c. only	no	yes

military products

requirements and screening flows

description of requirements and screens	MIL-M-38510 and MIL-STD-883 requirements, methods and test conditions	requirement	processing levels			
			class A	JAN qualified (JB)	/883B (RB)	/883C (RC)
General Mil-M-38510						
1 Pre-certification a Prod. assurance program plan b Manufacturer's certification	The manufacturer shall establish and implement a products assurance program plan and provide for a manufacturer survey by the qualifying activity, Para. 3.4.1.1	–	X	X	n.a.	n.a.
2 Certification	Received after manufacturer has completed a successful survey, Para. 3.4.1.2	–	X	X	n.a.	n.a.
3 Device qualification	Device qualification shall consist of subjecting the desired device to groups A, B, C and D of method 5005 to tightened LTPD, Para. 3.4.1.2	–	X	X	n.a.	n.a.
4 Traceability	Traceability maintained back to a production lot, Para. 3.4.6	–	X	X	X	X
5 Country of origin	Devices must be manufactured, assembled, and tested within the U.S. or its territories, Para. 3.2.1	–	X	X	n.a.	n.a.
Screening per method 5004 of Mil-Std-883						
6 Internal visual (pre-cap)	2010. cond. A or B	100%	XA	XB	XB	XB
7 Stabilization bake	1008. cond. C min; (24 h at 150 °C)	100%	X	X	X	X
8 Temperature cycling	1010. cond. C (10 cycles, –65 to +150 °C)	100%	X	X	X	X
For class B and C devices thermal shock may be substituted, 1011, cond. A; (15 cycles, 0 to +100 °C)						
9 Constant acceleration	2001, cond. E; (30 000g in Y1 plane)	100%	X	X	X	X
10 Visual inspection	There is no test method for this screen; it is intended only for the removal of 'Catastrophic Failures' defined as 'Missing Leads, Broken Packages or Lids Off'.	100%	X	X	X	X
11 Seal (hermeticity)	1014					
a Fine	cond. A or B (5,0 x 10^{-8} cm^3/s)	100%	X	X	X	X
b Gross	cond. C2 min.	100%	X	X	X	X
12 Interim electricals (pre-burn-in)	Per applicable device specification	100% optional	100% read & record	slash sheet	data sheet	n.a.
13 Burn-in	1015. cond. as specified (min 160 h at 125 °C)	100%	100% 240 h	X	X	n.a.

X = applicable
n.a. = not applicable

description of requirements and screens	MIL-M-38510 and MIL-STD-883 requirements methods and test conditions	requirement	processing levels			
			class A	JAN qualified (JB)	/883B (RB)	/883C (RC)
Screening per method 5004 of Mil-Std-883 (cont.)						
14 Final electricals	Per applicable device specification	100%	100% read & record	slash sheet	data sheet	data sheet
a Static tests, at 25 °C	Sub-group 1		X	X	X	X
b Static tests, at +125 °C	Sub-group 2		X	X	X	n.a.
c Static tests, at –55 °C	Sub-group 3		X	X	X	n.a.
d Dynamic test, at 25 °C	Sub-group 4 (for linear product mainly)		X	X	X	X
e Functional test, at 25 °C	Sub-group 7		X	X	X	X
f Switching test, at 25 °C	Sub-group 9		X	X	X	n.a.
15 Percent Defective Allowable (PDA)	A PDA of 10% is a normal requirement applied against the static test at 25 °C (A-1). This is controlled by the slash sheets for JB & JBX products. For RBX & RB 10% is standard.	10%	5%	X	X	n.a.
16 Marking (between brackets meaning of xxxx)	Fungus inhibiting paint	100%	as req'd	JM38510 /xxx (slash sheet no)	Sxxxx /883B (Sig. basic no)	Sxxxx /883C (Sig. basic no)
17 X-ray	2012		100%	n.a.	n.a.	n.a.
18 External visual	2009	100%	X	X	X	X
Quality conformance inspection per method 5005 of Mil-Std-883						
19 Group A	Electrical tests – final electricals (no 14 above) repeated on a sample basis. (Sub-groups 1 to 12 as specified).	each lot	X	X	X	X
20 Group B	Package functional and constructional related test i.e. package dimensions, resistance to solvents, internal visual and mechanical, bond strength and solderability.	every 6 weeks per package type	X	X	generic data available	
21 Group C	Die related tests i.e. 1000 h operating life, temperature cycling and constant acceleration.	every 3 months per microcircuit group	n.a.*	X	generic data available	
22 Group D	Package related tests i.e. physical dimensions, lead fatigue, thermal shock, temperature cycle, moisture resistance, mechanical shock, vibration variable frequency constant acceleration and salt atmosphere.	every 6 months per package type	X	X	generic data available	

* For class A devices these tests are included in Group B.

military products

JAN 38510 type numbers – what they mean

The following chart is offered for your reference to help take some of the mystery out of JAN part number marking. For an example, we will take the marking for a 5400F processed to JAN and explain its meaning as well as other options.

JM38510 /001 04 B C B

MILITARY DESIGNATOR

calls out

MIL-M-38510

JAN IC

The "J" in the marking is very important.

If it's not there it's not a JAN device.

DO NOT be confused by JAN equivalents marked M38510.

DETAIL SPECIFICATION

refers to detail slash sheet spec 001, 002, 003 ----

A slash sheet detail spec will usually represent a family of devices with similar functions.

i.e. the /001 detail spec represents many positive NAND gates such as the 5400, 5401, 5403, 5410, 5420 and 5430 etc.

The /002 detail spec on the other hand represents many flip-flop functions such as the 5472, 5473, 54107, 5476, 5474, 5470 and so on for the rest of the slash sheets.

DEVICE TYPE

refers to a specific part type under the detail spec.

This, plus the detail spec no. will denote a part type.

i.e.:

detail spec	+	dev. type	=	generic type
001		01	=	5430
001		02	=	5420
001		03	=	5410
001		04	=	5400

detail spec	+	dev. type	=	generic type
002		01	=	5472
002		02	=	5473
002		03	=	54107

and so on for the rest of the slash sheets.

Actual marking for our 5400F
as it appears on the device.

SAAAA — date code
JM38510
00104
BCB
CDKB — Signetics manufacturer's code (per Mil-M-38510)

DEVICE CLASS

calls out processing to either class A **B** or C of MIL-STD-883

CASE OUTLINE

This code denotes the package i.e.:

A = ¼" x ¼" flat pack 14 pin
B = ¼" x ⅛" flat pack 14 pin
C = ¼" x ¾" 14 pin dual in-line
D = ¼" x ⅜" flat pack 14 pin
E = ¼" x ¾" 16 pin dual in-line
F = ¼" x ⅜" flat pack 16 pin
G = 8 lead metal can
H = ¼" x ¼" 10 pin flat pack
I = 10 lead metal can
J = ½" x 1¼" 24 pin dual in-line
K = ⅜" x ½" 24 pin flat pack
L = ⅜" x ½" 24 pin flat pack
Z = ¼" x ⅜" 24 pin flat pack

LEAD FINISH

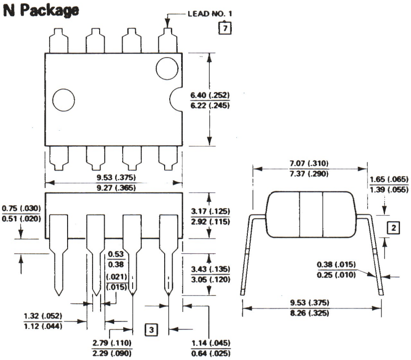
A = Kovar or alloy 42 with hot solder dip
B = Kovar or alloy 42 with tin plate
C = Kovar or alloy with gold plate

packages

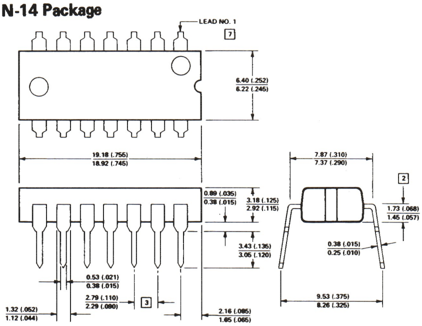
PLASTIC: Standard Dual-In-Line

Number of pins
N Package: 8, 14, 16, 20, 22, 24, 28, 40
P Package: 16

N Package


LEAD NO. 1
7
6.40 (.252)
6.22 (.245)
9.53 (.375)
9.27 (.365)
7.07 (.310)
7.37 (.290)
1.65 (.065)
1.39 (.055)
0.75 (.030)
0.51 (.020)
3.17 (.125)
2.92 (.115)
2
0.53
0.38
(.021)
(.015)
3.43 (.135)
3.05 (.120)
0.38 (.015)
0.25 (.010)
9.53 (.375)
8.26 (.325)
1.32 (.052)
1.12 (.044)
3
2.79 (.110)
2.29 (.090)
1.14 (.045)
0.64 (.025)

N-14 Package


LEAD NO. 1
7
6.40 (.252)
6.22 (.245)
19.18 (.755)
18.92 (.745)
7.87 (.310)
7.37 (.290)
2
0.89 (.035)
0.38 (.015)
3.18 (.125)
2.92 (.115)
1.73 (.068)
1.45 (.057)
3.43 (.135)
3.05 (.120)
0.38 (.015)
0.25 (.010)
0.53 (.021)
0.38 (.015)
2.79 (.110)
2.29 (.090)
3
9.53 (.375)
8.26 (.325)
1.32 (.052)
1.12 (.044)
2.16 (.085)
1.65 (.065)

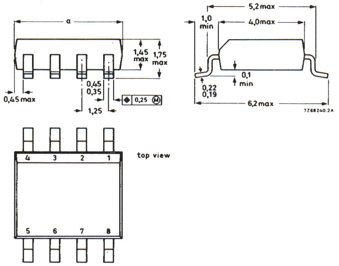
PLASTIC: Miniature Dual-In-Line

Number of pins SO Package: 6, 8, 10, 14, 16

SO Package (SO-8 as example)

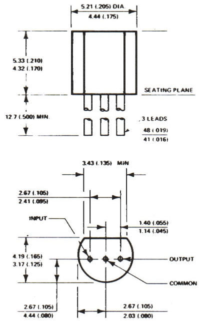
dimensions a

	SO-6	SO-8	SO-10	SO-14	SO-16
min.	3,55	4,8	6,05	8,55	9,8
max.	3,75	5,0	6,25	8,75	10,0

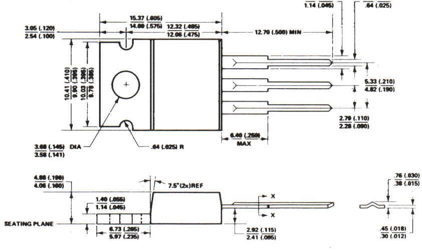

a
1,45 max
1,75 max
0,45 max
0,45
0,35
0,25 M
1,25
5,2max
1,0 min
4,0max
0,1 min
0,22
0,19
6,2max
7Z68240.2A
4
3
2
1
5
6
7
8
top view

PLASTIC: Power

S Package

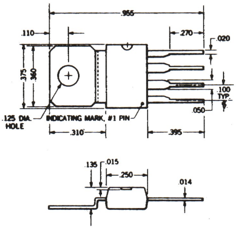

5.21 (.205) DIA.
4.44 (.175)
5.33 (.210)
4.32 (.170)
SEATING PLANE
12.7 (.500) MIN.
3 LEADS
.48 (.019)
.41 (.016)
3.43 (.135) MIN
2.67 (.105)
2.41 (.095)
INPUT
1.40 (.055)
1.14 (.045)
4.19 (.165)
3.17 (.125)
OUTPUT
COMMON
2.67 (.105)
4.44 (.080)
2.67 (.105)
2.03 (.080)

U Package


1.40 (.055)
1.14 (.045)
1.14 (.045)
.64 (.025)
15.37 (.605)
14.60 (.575)
12.32 (.485)
12.06 (.475)
3.05 (.120)
2.54 (.100)
12.70 (.500) MIN
10.41 (.410)
9.90 (.390)
10.03 (.395)
9.78 (.385)
5.33 (.210)
4.82 (.190)
2.79 (.110)
2.28 (.090)
6.60 (.260) MAX
3.68 (.145) DIA
3.58 (.141)
.64 (.025) R
4.88 (.190)
4.06 (.160)
7.5°(2x)REF
1.40 (.055)
1.14 (.045)
SEATING PLANE
6.73 (.265)
5.97 (.235)
X
X
2.92 (.115)
2.41 (.095)
.76 (.030)
.38 (.015)
.45 (.018)
.30 (.012)

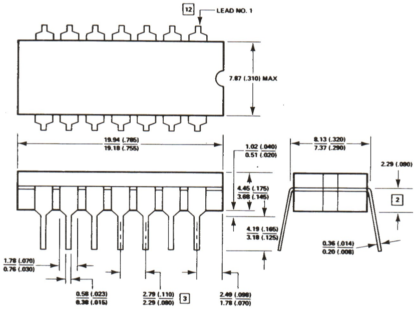
NOTE: 1. LEAD MATERIAL – COPPER, NICKEL PLATED, SOLDER DIPPED.

U1 Package

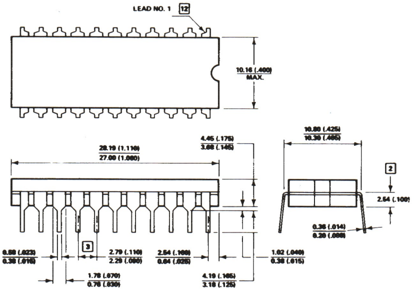

.955
.110
.270
.020
.375
.360
.100 TYP.
.050
.125 DIA. HOLE
INDICATING MARK, #1 PIN
.310
.395
.135
.015
.250
.014

HERMETIC: Cerdip Number of pins F Package: 14, 16, 18, 22, 24

F Package 14 pin

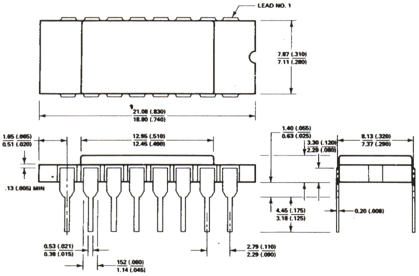

12
LEAD NO. 1
7.87 (.310) MAX
19.94 (.785)
19.18 (.755)
1.02 (.040)
0.51 (.020)
8.13 (.320)
7.37 (.290)
2.29 (.090)
4.45 (.175)
3.68 (.145)
2
4.19 (.165)
3.18 (.125)
0.36 (.014)
0.20 (.008)
1.78 (.070)
0.76 (.030)
0.58 (.023)
0.38 (.015)
2.79 (.110)
2.29 (.090)
3
2.49 (.098)
1.78 (.070)

F Package 22-pin


LEAD NO. 1
12
10.16 (.400)
MAX.
4.45 (.175)
3.68 (.145)
28.19 (1.110)
27.00 (1.080)
10.80 (.425)
10.30 (.405)
2
2.54 (.100)
0.36 (.014)
0.20 (.008)
0.58 (.023)
0.38 (.015)
3
2.79 (.110)
2.29 (.090)
2.54 (.100)
0.64 (.025)
1.02 (.040)
0.38 (.015)
1.78 (.070)
0.76 (.030)
4.19 (.165)
3.18 (.125)

HERMETIC: Metal ceramic Dual-in-Line Number of pins E Package: 16, 18
I Package: 16, 18, 24, 28, 40, 50

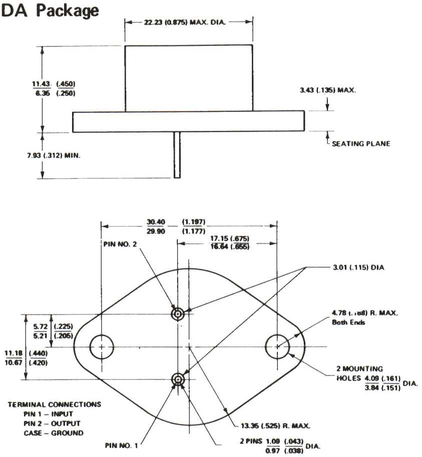
E or I package 16 pin


LEAD NO. 1
7.87 (.310)
7.11 (.280)
21.08 (.830)
18.80 (.740)
1.65 (.065)
0.51 (.020)
12.95 (.510)
12.45 (.490)
1.40 (.055)
0.63 (.025)
3.30 (.120)
2.29 (.080)
8.13 (.320)
7.37 (.290)
.13 (.005) MIN
4.45 (.175)
3.18 (.125)
0.20 (.008)
0.53 (.021)
0.38 (.015)
152 (.060)
1.14 (.045)
2.79 (.110)
2.29 (.090)

packages

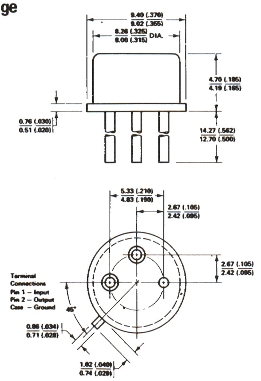
HERMETIC: Metal Headers

DA Package



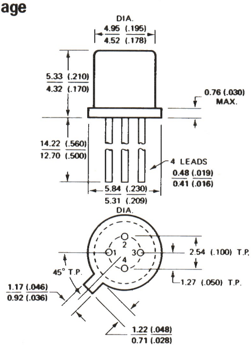
22.23 (0.875) MAX. DIA.
11.43 (.450)
6.35 (.250)
3.43 (.135) MAX.
SEATING PLANE
7.93 (.312) MIN.
30.40 (1.197)
29.90 (1.177)
17.15 (.675)
16.64 (.655)
PIN NO. 2
3.01 (.115) DIA
4.78 (.188) R. MAX.
Both Ends
5.72 (.225)
5.21 (.205)
11.18 (.440)
10.67 (.420)
2 MOUNTING HOLES 4.09 (.161) 3.84 (.151) DIA.
TERMINAL CONNECTIONS
PIN 1 – INPUT
PIN 2 – OUTPUT
CASE – GROUND
13.36 (.525) R. MAX.
2 PINS 1.09 (.043) 0.97 (.038) DIA.
PIN NO. 1

DB Package



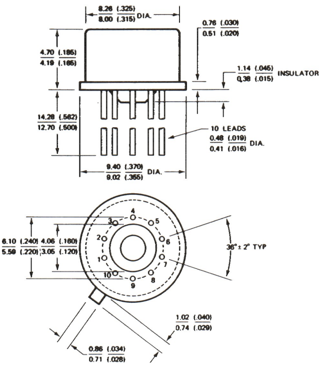
9.40 (.370)
9.02 (.355)
8.26 (.325)
8.00 (.315) DIA.
4.70 (.185)
4.19 (.165)
0.76 (.030)
0.51 (.020)
14.27 (.562)
12.70 (.500)
5.33 (.210)
4.83 (.190)
2.67 (.105)
2.42 (.095)
2.67 (.105)
2.42 (.095)
Terminal Connections
Pin 1 – Input
Pin 2 – Output
Case – Ground
45°
0.86 (.034)
0.71 (.028)
1.02 (.040)
0.74 (.029)

DE Package



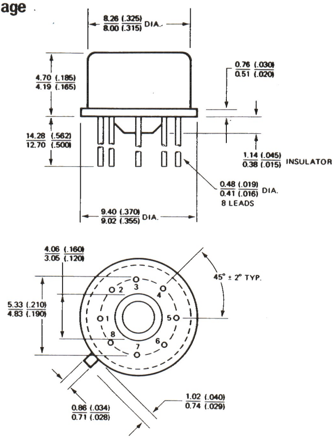
DIA.
4.95 (.195)
4.52 (.178)
5.33 (.210)
4.32 (.170)
0.76 (.030) MAX.
14.22 (.560)
12.70 (.500)
4 LEADS
0.48 (.019)
0.41 (.016)
5.84 (.230)
5.31 (.209)
DIA.
1
2
3
4
2.54 (.100) T.P.
45° T.P.
1.17 (.046)
0.92 (.036)
1.27 (.050) T.P.
1.22 (.048)
0.71 (.028)

K Package



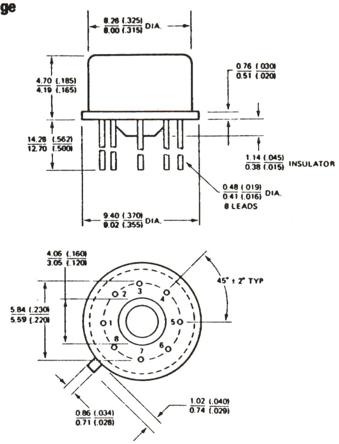
8.26 (.325)
8.00 (.315) DIA.
0.76 (.030)
0.51 (.020)
4.70 (.185)
4.19 (.165)
1.14 (.045)
0.38 (.015) INSULATOR
14.28 (.562)
12.70 (.500)
10 LEADS
0.48 (.019)
0.41 (.016) DIA.
9.40 (.370)
9.02 (.355) DIA.
1
2
3
4
5
6
7
8
9
10
6.10 (.240)
5.59 (.220)
4.06 (.160)
3.05 (.120)
36° ± 2° TYP
1.02 (.040)
0.74 (.029)
0.86 (.034)
0.71 (.028)

T Package



8.26 (.325)
8.00 (.315) DIA.
4.70 (.185)
4.19 (.165)
0.76 (.030)
0.51 (.020)
14.28 (.562)
12.70 (.500)
1.14 (.045)
0.38 (.015) INSULATOR
0.48 (.019)
0.41 (.016) DIA.
8 LEADS
9.40 (.370)
9.02 (.355) DIA.
4.06 (.160)
3.05 (.120)
45° ± 2° TYP.
5.33 (.210)
4.83 (.190)
1
2
3
4
5
6
7
8
0.86 (.034)
0.71 (.028)
1.02 (.040)
0.74 (.029)

TA package



8.26 (.325)
8.00 (.315) DIA.
4.70 (.185)
4.19 (.165)
0.76 (.030)
0.51 (.020)
14.28 (.562)
12.70 (.500)
1.14 (.045)
0.38 (.015) INSULATOR
0.48 (.019)
0.41 (.016) DIA.
8 LEADS
9.40 (.370)
9.02 (.355) DIA.
4.06 (.160)
3.05 (.120)
45° ± 2° TYP
5.84 (.230)
5.59 (.220)
1
2
3
4
5
6
7
8
0.86 (.034)
0.71 (.028)
1.02 (.040)
0.74 (.029)

CONTENTS RESISTORS

For detailed information
Handbook CM2a

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FIXED RESISTORS	carbon film		C2 – C3
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	metal film – power		C7
	high voltage		C8
	wirewound		C9 – C12
	test switches		C13
VARIABLE RESISTORS	preset potentiometers	miniature carbon	C14
		carbon	C15 – C17
		cermet	C18
		wirewound	C19
		multiturn carbon	C20 – C21
	control potentiometers	carbon	C22 – C29
		slide carbon	C30 – C35
		wirewound	C36 – C39
	focus control	carbon	C40
NON-LINEAR RESISTORS	VDR		C41 – C44
	LDR		C45
	NTC thermistors		C46 – C57
	PTC thermistors		C58 – C69
STANDARD SERIES	standard series to IEC 63		C70

fixed resistors

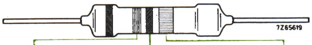
carbon film

CR16 CR25 CR37
CR52 CR68 CR93

Status D

For detailed information
Handbook CM2a

Resistance range	1 Ω to 10 MΩ; E12 or E24			
Resistance tolerance	± 5 or ± 10%			
Abs. max. dissipation	CR16	0,2 W	CR52	0,67 W
at T_{amb} = 70 °C	CR25	0,33 W	CR68	1,15 W
	CR37	0,5 W	CR93	2 W
Basic specification	IEC 115-1, 115-2			
Climatic category (IEC 68)	55/155/56			
Stability after load	see nomogram			



colour	first two digits of resistance value	multiplier	tolerance
black	0	1 x	
brown	1	10 x	
red	2	100 x	
orange	3	1 000 x	
yellow	4	10 000 x	
green	5	100 000 x	
blue	6	1 000 000 x	
violet	7		
grey	8		
white	9		
silver			± 10%
gold		0,1 x	± 5%

style	limiting voltage V (r.m.s.)	**rated dissipation at T_{amb} = 70 °C W**	resistance range	tolerance ± %	series	catalogue no.
CR16	150	**0,2**	10 Ω – 220 kΩ	5	E24	2322 210 13 . . .
			270 kΩ – 1 MΩ	10	E12	2322 210 12 . . .
CR16 on reel			10 Ω – 220 kΩ	5	E24	2322 210 23 . . .
			270 kΩ – 1 MΩ	10	E12	2322 210 22 . . .
CR25	150	**0,33**	1 Ω – 1 MΩ	5	E24	2322 211 13 . . .
			1,2 MΩ – 10 MΩ	10	E12	2322 211 12 . . .
CR25 on reel			1 Ω – 1 MΩ	5	E24	2322 211 23 . . .
			1,2 MΩ – 10 MΩ	10	E12	2322 211 22 . . .
CR25A	250	**0,33**	1 Ω – 1 MΩ	5	E24	2322 106 33 . . .
			1,2 MΩ – 10 MΩ	10	E12	2322 106 32 . . .
CR37	350	**0,5**	1 Ω – 1 MΩ	5	E24	2322 212 13 . . .
			1,2 MΩ – 10 MΩ	10	E12	2322 212 12 . . .
CR37 on reel			1 Ω – 1 MΩ	5	E24	2322 212 23 . . .
			1,2 MΩ – 10 MΩ	10	E12	2322 212 22 . . .
CR52*	500	**0,67**	1 Ω – 1 MΩ	5	E24	2322 213 13 . . .
CR68*	750	**1,15**	1 Ω – 1 MΩ	5	E24	2322 214 13 . . .
CR93*	1000	**2**	10 Ω – 1 MΩ	5	E24	2322 215 13 . . .

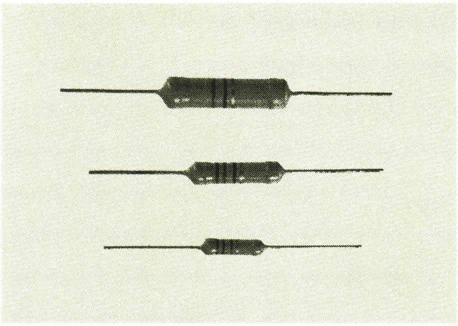
* For values > 1 MΩ see high-voltage resistors VR37 and VR68.

Composition of the catalogue no.

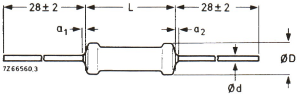
In the above-mentioned catalogue no., replace the first two dots by the first two digits of the resistance value.
Replace the third dot by a figure according to the following table:

1 – 9,1 Ω	8	10 – 91 kΩ	3
10 – 91 Ω	9	100 – 910 kΩ	4
100 – 910 Ω	1	1 – 9,1 MΩ	5
1 – 9,1 kΩ	2	10 MΩ	6

Example
Style CR25 (not on reel) 10 Ω, 5% cat. no. 2322 211 13109

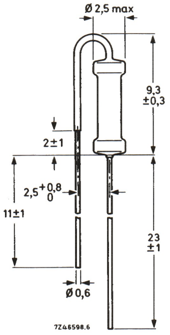


style	D_{max}	L_{max}	d	$a_1 + a_2$
CR16	1,6	4,0	0,4	⩽ 1,0
CR25	2,5	6,5	0,6	⩽ 1,0
CR37	3,7	10	0,7	⩽ 1,0
CR52	5,2	16,5	0,8	⩽ 1,2
CR68	6,8	18	0,8	⩽ 1,2
CR93	9,0	31,7	0,8	⩽ 1,2

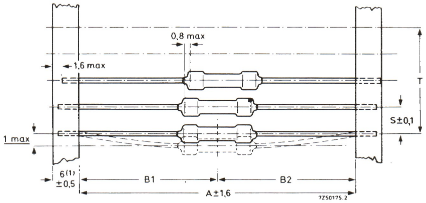

28 ± 2
L
28 ± 2
a_1
a_2
ØD
Ød
7Z66560.3

Style CR25A

The bent lead is partly covered with an insulating lacquer having a breakdown voltage of at least 50 V(d.c.)


Ø 2,5 max
9,3 ±0,3
2±1
$2,5^{+0,8}_{0}$
11±1
23 ±1
Ø 0,6
7Z46598.6

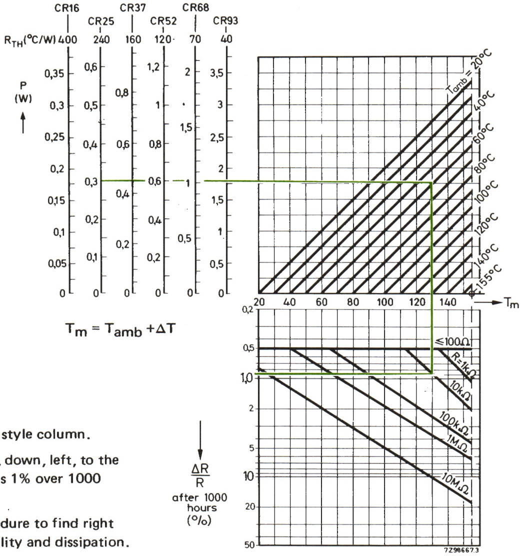
Configuration of reel


0,8 max
1,6 max
T
S±0,1
1 max
6(1) ±0,5
B1
B2
A±1,6
7Z50175.2

(1) For styles CR52 and CR68 : 5 mm.

style	A	B1-B2 ± max	S	T for number (n) of resistors n < 50	 50 < n < 100
CR16	52,4	1,2	5	5(n – 1) ± 2	5(n – 1) ± 4
CR25	52,4	1,2	5	5(n – 1) ± 2	5(n – 1) ± 4
CR37	52,4	1,2	5	5(n – 1) ± 2	5(n – 1) ± 4
CR52	66,7	1,2	10	10(n – 1) ± 2	10(n – 1) ± 4
CR68	66,7	1,2	10	10(n – 1) ± 2	10(n – 1) ± 4
CR93	92*	1,2	10	10(n – 1) ± 2	10(n – 1) ± 4

* Tolerance ± 2 mm.



Nomogram to find style or stability

Example
What is the stability of a 10 kΩ resistor, style CR25, operating at 0,3 W in an ambient of 60 °C ?

Find 0,3 W on CR25 style column.

Follow the line right, down, left, to the stability axis. ΔR/R is 1% over 1000 working hours.

Use the reverse procedure to find right style for a given stability and dissipation.

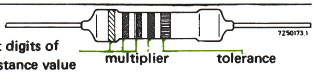
fixed resistors

metal film - lacquered

MR25 MR30 MR52

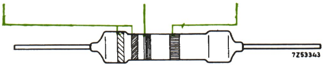
Status D

Resistance range	1 Ω to 1 MΩ E24, E96 and E192 series
Resistance tolerance	± 0,5, ± 1, ± 2, ± 5%
Temperature coefficient	± 50, ± 100, ± 200 ppm/ °C
Abs. max. dissipation at T_{amb} = 70 °C	MR25 0,4 W MR30 0,5 W MR52 0,75 W
Basic specification	IEC 115-1
Climatic category (IEC 68)	55/155/56
Stability after load	see nomogram



for E96 series E192 series colour	first digits of resistance value	multiplier	tolerance
black	0	1 x	
brown	1	10 x	± 1%
red	2	100 x	± 2%
orange	3	1 000 x	
yellow	4	10 000 x	
green	5	100 000 x	± 0,5%
blue	6		
violet	7		
grey	8		
white	9		
silver		0,01 x	
gold		0,1 x	± 5%

for E24 series



style	limiting voltage (r.m.s) V	rated dissipation at T_{amb} = 70 °C W	resistance range	tolerance ± %	series	temperature coefficient ± ppm/ °C	catalogue no. 2322 followed by
MR25	250	**0,4**	4,99 Ω – 681 kΩ	0,5	E192	**50***	151 7 . . . .
	250		4,99 Ω – 681 kΩ	1	E96 + E24	**50***	151 5 . . . .
	250		1 Ω – 680 kΩ	2	E24	100	151 4 . . . .
	250		1 Ω – 680 kΩ	5	E24	200	151 6 . . . .
MR25 on reel	250		4,99 Ω – 681 kΩ	1	E96	**50***	151 2 . . . .
	250		1 Ω – 680 kΩ	2	E24	100	151 1 . . . .
	250		1 Ω – 680 kΩ	5	E24	200	151 3 . . . .
MR30	350	**0,5**	4,99 Ω – 1 MΩ	0,5	E192	**50***	152 7 . . . .
	350		4,99 Ω – 1 MΩ	1	E96 + E24	**50***	152 5 . . . .
	350		5,1 Ω – 1 MΩ	2	E24	100	152 4 . . . .
	350		5,1 Ω – 1 MΩ	5	E24	200	152 6 . . . .
MR30 on reel	350		4,99 Ω – 1 MΩ	1	E96	**50***	152 2 . . . .
	350		5,1 Ω – 1 MΩ	2	E24	100	152 1 . . . .
	350		5,1 Ω – 1 MΩ	5	E24	200	152 3 . . . .
MR52	500	**0,75**	4,99 Ω – 1 MΩ	1	E96	100	153 5 . . . .

*For values ⩽ 49,9 Ω: 100 ppm/ °C.

Composition of the catalogue no. 2322 . . . .

Style code
see table

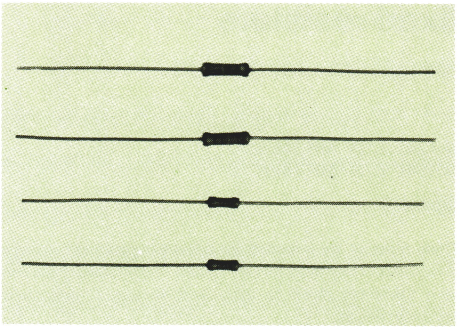
Tolerance code
see table

Resistance code: first three figures of the resistance value followed by

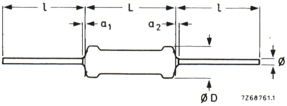
8 for R of	1 to 9,76 Ω
9 for R of	10 to 97,6 Ω
1 for R of	100 to 976 Ω
2 for R of	1 to 9,76 kΩ.
3 for R of	10 to 97,6 kΩ
4 for R of	100 to 976 kΩ
5 for R of	1 MΩ

Example
The catalogue no. of an MR30 resistor of 3650 Ω with a tolerance of 1% is 2322 152 53652.

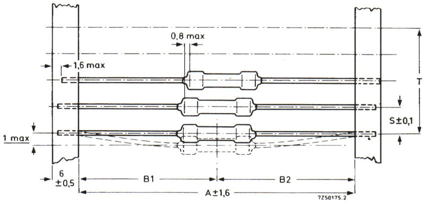
A professional style of resistor that is also widely used in consumer equipment. It meets the high standards required for test and measuring equipment and for communications equipment etc. The lacquer is non-inflammable and is resistant to all the usual cleansing solvents.



style	D_{max}	L_{max}	l	d	a_{max}
MR25	2,5	6,5	28 ± 2	0,6	⩽ 1
MR30	3	10	28 ± 2	0,6	⩽ 1
MR52	5,2	16,5	38 ± 3	0,6	⩽ 1



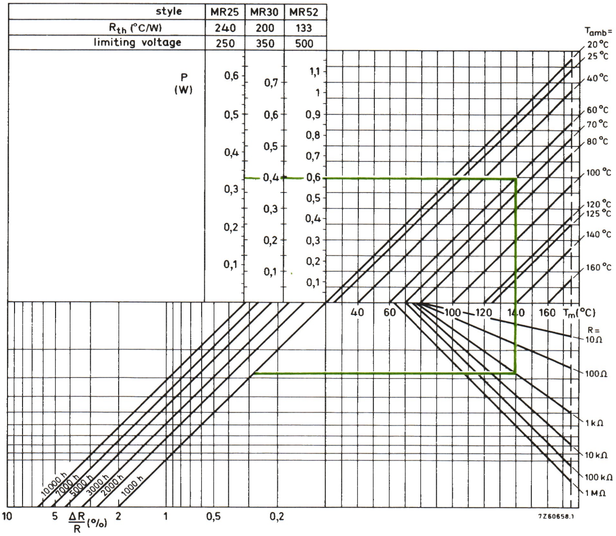
Configuration of reel



style	A	B1-B2 ± max	S	T for number (n) of resistors n ⩽ 50	T for number (n) of resistors 50 < n ⩽ 100
MR25	52,4	1,2	5	5(n – 1) ± 2	5(n – 1) ± 4
MR30	52,4	1,2	5	5(n – 1) ± 2	5(n – 1) ± 4
MR52	66,7	1,2	10	10(n – 1) ± 2	10(n – 1) ± 4

Nomogram to find style or stability

Example
What is the stability of a 1 kΩ metal film resistor, style MR25, operating at 0,33 W in an ambient of 60 °C? Find 0,33 W on MR25 style column. Follow the line right, down, left, to where it intersects the 1000 h line.
ΔR/R is 0,28% over 1000 working hours.
Use the reverse procedure to find right style for a given stability and dissipation.



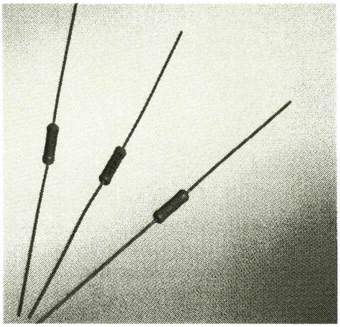
fixed resistors

metal film - lacquered

MR24E/C/D MR34E/C/D
MR54E/C/D MR74E/C/D

Status D

These resistors are intended for demanding applications where MIL-STD is required. They meet MIL-R-10509F in all respects and can be supplied with tolerances down to 0,1% and, to special order, in non-standard resistance values.



Resistance range	10 Ω to 1 MΩ, E96, E192 series	
Resistance tolerance	± 0,1 ± 0,25 ± 0,5 ± 1%	
Rated dissipation		
at T_{amb} = 125 °C	MR24E/C	0,1 W
	MR34E/C	0,125 W
	MR54E/C	0,25 W
	MR74E/C	0,5 W
at T_{amb} =70 °C	MR24D	0,125 W
	MR34D	0,25 W
	MR54D	0,5 W
	MR74D	0,75 W
Basic specification	MIL-R-10509F	
Stability after load	ΔR/R max 0,5% +0,05 Ω	

style	max voltage V(r.m.s.)	**rated dissipation** **W**	resistance range and tolerance	maximum temperature coefficient ppm/°C	MIL style	style code
		at T_{amb} = 125 °C	0,1/0,25/0,5% E192 series 1% E96 series	±		
MR24E	200	**0,1**	49,9 Ω–100 kΩ	25	RN55E	160
MR24C	200	**0,1**	49,9 Ω–100 kΩ	50	RN55C	161
MR34E	250	**0,125**	'49,9 Ω–499 kΩ	25	RN60E	163
MR34C	250	**0,125**	49,9 Ω–499 kΩ	50	RN60C	164
MR54E	300	**0,25**	49,9 Ω– 1 MΩ	25	RN65E	166
MR54C	300	**0,25**	49,9 Ω– 1 MΩ	50	RN65C	167
MR74E	350	**0,5**	24,9 Ω– 1 MΩ	25	RN70E	169
MR74C	350	**0,5**	24,9 Ω– 1 MΩ	50	RN70C	170
		at T_{amb} = 70 °C	1% E96 series	±		
MR24D	200	**0,125**	10 Ω–301 kΩ	100	RN55D	162
MR34D	300	**0,25**	10 Ω– 1 MΩ	100	RN60D	165
MR54D	350	**0,5**	10 Ω– 1 MΩ	100	RN65D	168
MR74D	500	**0,75**	10 Ω– 1 MΩ	100	RN70D	171

Composition of the catalogue no.

2322 ... .

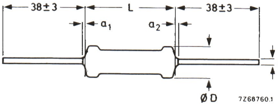
Style code
see table

Tolerance code*
1 for ± 1%
2 for ± 0,5%
3 for ± 0,25%
4 for ± 0,1%

Resistance code*: first three digits of the resistance value followed by
9 for R of 10 to 98,8 Ω
1 for R of 100 to 988 Ω
2 for R of 1 to 9,88 kΩ
3 for R of 10 to 98,8 kΩ
4 for R of 100 to 988 kΩ
5 for R of 1 MΩ

Example
Style MR24E, 261 kΩ, 0,25%; catalogue no. 2322 160 32614.

style	D_{max}	L_{max}	d	$a_1 + a_2$
MR24 E/C/D	2,5	6,5	0,6	1
MR34 E/C/D	3,1	10,5	0,6	1
MR54 E/C/D	5,2	16,5	0,6	1
MR74 E/C/D	6,8	20,5	0,8	1



Marking: (to MIL-R-10509 F)
Each resistor is marked with
MIL style
value and tolerance in MIL code
manufacturer's indentification symbol

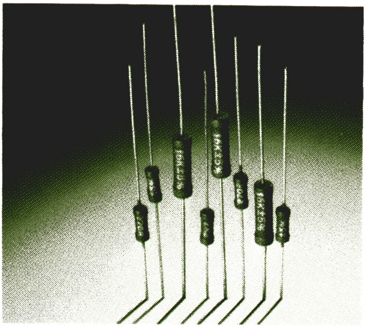
* Where following values occur,
use numbers shown below.

value Ω	last 5 digits of the catalogue no. 0,1%	0,25%	0,5%	1%
29,9	92102	92122		
39,9	92103	92123		
49,9	92104	92124	92134	92144
59,9	92105	92125		
69,9	92106	92126		
79,9	92107	92127		
89,9	92108	92128		
99,9	92109	92129		

metal film - power

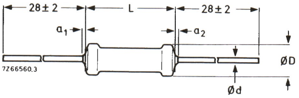
PR37 PR52

Status D

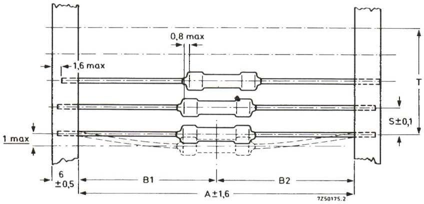


Resistance range	PR37 10 Ω to 10 kΩ, E24 series PR52 10 Ω to 27 kΩ, E24 series	
Resistance tolerance	± 5%	
Max body temperature (hot spot)	300 °C	
Rated dissipation at T_{amb} = 70 °C	PR37 1,6 W PR52 2,5 W	
Basic specification	MIL-R-11804/2B, char. G	
Climatic category (IEC 68)	55/200/56	
Stability after 1000 h max load	requirement ΔR ⩽ 5%	typical value ΔR 2,5%

style	L_{max}	D_{max}	$a_1 + a_2$	d_{max}
PR37	10,0	3,7	⩽ 1	0,6
PR52	16,7	5,2	⩽ 1,2	0,6



Configuration of reel



style	A	B1-B2 ± max	S	T for number (n) of resistors n ⩽ 50	 50 < n ⩽ 100
PR37	52,4	1,2	5	5(n − 1) ± 2	5(n − 1) ± 4
PR52	66,7	1,2	10	10(n − 1) ± 2	10(n − 1) ± 4

Marking

Each resistor is marked with
resistance value (R for Ω, K for kΩ)
tolerance on resistance
e.g. for 27 Ω: 27R ± 5%
for 3,9 kΩ: 3K9 ± 5%

Composition of the catalogue no.

2322 19 . 3 . . 0.

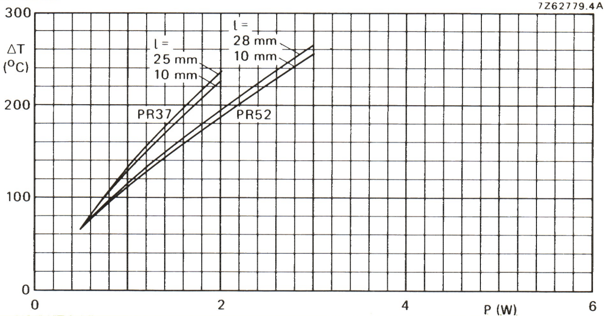
Style code
191 for PR37
192 for PR52

9 for R of 10 to 91 Ω
1 for R of 100 to 910 Ω
2 for R of 1000 to 9100 Ω
3 for R of 10000 to 27000 Ω

Tolerance code
3 for ± 5%

First two digits of the resistance value (E24 series)

Example:
PR52, 240 Ω, ± 5%
catalogue no. 2322 192 32401



ΔT = Hot-spot temperature rise.

fixed resistors

high voltage

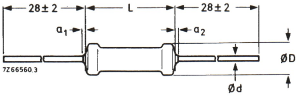
VR37 VR68

Status D

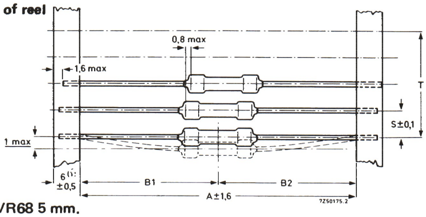
A range of metal-glazed resistors especially intended for stability and reliability at high voltages. They are commonly used as protection resistors in tv and radio touch control systems.

Resistance range	VR37 1 MΩ to 33 MΩ, E24 and E96 VR68 1 MΩ to 68 MΩ, E24 and E96
Resistance tolerance	± 1% (E96) or ± 5% (E24)
Max body temperature (hot spot)	155 °C
Temperature coefficient	± 200 ppm/ °C
Rated dissipation at T_{amb} = 70 °C	VR37 0,5 W VR68 1,0 W
Limiting voltage	VR37 3500 V(d.c.) or 2500 V(r.m.s.) VR68 10000 V(d.c.) or 7000 V(r.m.s.)
Dielectric withstanding voltage of the insulation for 1 minute	min 700 V(r.m.s.)
Basic specification	IEC 115, type 1 B
Climatic category (IEC 68)	55/155/56
Noise	0,5 μV/V
Stability after 1000 h max load	VR37 VR68 ΔR 0,5% ΔR 1%

style	L_{max}	D_{max}	$a_1 + a_2$	d
VR37	10	3,7	⩽ 1,0	0,7
VR68	18	6,8	⩽ 1,2	0,8



Configuration of reel



(1) For style VR68 5 mm.

style	A	B1-B2 ± max	S	T for number (n) of resistors n ⩽ 50	 50 < n ⩽ 100
VR37	52,4	1,2	5	5(n − 1) ± 2	5(n − 1) ± 4
VR68	66,7	1,2	10	10(n − 1) ± 2	10(n − 1) ± 4

Composition of the catalogue no.

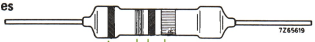
2322 . . . .

style code
242 for VR37
244 for VR68

5 for R of 1 MΩ to 9,76 MΩ
6 for R of 10 MΩ to 68 MΩ

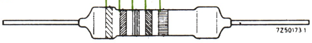
E24: 13 + first two digits of the resistance value
E96: 8 + first three digits of the resistance value

E24 series



colour	first digits of resistance value	multiplier	tolerance
black	0		
brown	1		± 1%
red	2		
orange	3		
yellow	4	10 000 x	± 5%
green	5	100 000 x	
blue	6	1 000 000 x	
violet	7	10 000 000 x	
grey	8		
white	9		

E96 series

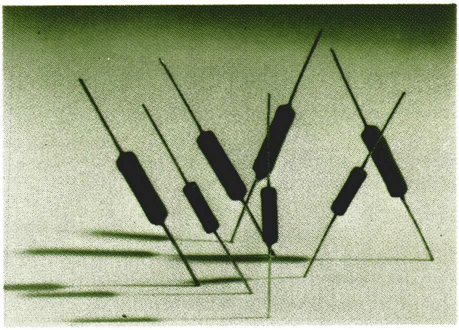


cemented wirewound

AC04 AC05 AC07
AC10 AC15 AC20

Status D

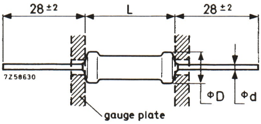
These wirewound resistors are specially designed to dissipate high loads in a small volume.
The resistor is coated with a green silicon cement which is non-inflammable and cannot drip at high overloads.



Resistance range	0,1 Ω to 33 kΩ E12 and E24 series
Resistance tolerance	± 5% or ± 10%
Maximum body temperature	350 °C
Rated dissipation at T_{amb} = 40 °C	AC04 4 W, AC10 10 W AC05 5 W, AC15 15 W AC07 7 W, AC20 20 W
Basic specification	IEC 266
Climatic category (IEC 68)	40/200/56
Stability after load	ΔR/R max 5%

style	D_{max}	L_{max}	d
AC04	6	19	0,6
AC05	8	19	0,8
AC07	8	27	0,8
AC10	8	44	0,8
AC15	10	51	0,8
AC20	10	67	0,8

style	rated dissipation (W) T_{amb} = 40 °C	 T_{amb} = 70 °C	resistance range Ω	tol. ± %	series	catalogue no. 2322 329
AC04	4	3,5	0,18 – 8,2	10	E12	34 . . .
			10 – 4700	5	E24	04 . . .
AC05	5	4,7	0,18 – 8,2	10	E12	35 . . .
			10 – 5600	5	E24	05 . . .
AC07	7	5,8	0,10 – 8,2	10	E12	37 . . .
			10 – 10 000	5	E24	07 . . .
AC10	10	8,4	0,68 – 8,2	10	E12	40 . . .
			10 – 15 000	5	E24	10 . . .
AC15	15	12,5	0,82 – 8,2	10	E12	45 . . .
			10 – 22 000	5	E24	15 . . .
AC20	20	16	1,2 – 8,2	10	E12	50 . . .
			10 – 33 000	5	E24	20 . . .

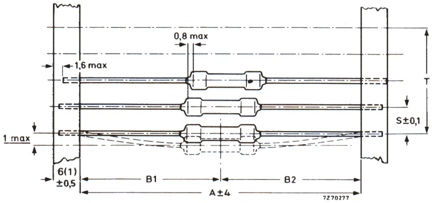


Composition of catalogue no.

In the catalogue no. (table left) replace the first two dots by the first two digits of the resistance value. Replace the third dot by a figure according to the following table:

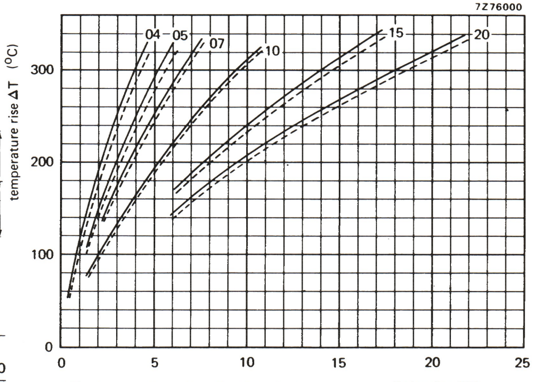
0,1	–	0,82	Ω: 7
1	–	8,2	Ω: 8
10	–	91	Ω: 9
100	–	910	Ω: 1
1 000	–	9 100	Ω: 2
10 000	–	33 000	Ω: 3

Configuration of reel



(1) For style AC104 5 or 6 mm.

style	A	B1-B2 ± max	S	T for number (n) of resistors n ⩽ 50	 50 < n ⩽ 100
AC04	66	1,2	10	10(n – 1) ± 2	10(n – 1) ± 4
AC05	66	1,2	10	10(n – 1) ± 2	10(n – 1) ± 4
AC07	74	1,2	10	10(n – 1) ± 2	10(n – 1) ± 4

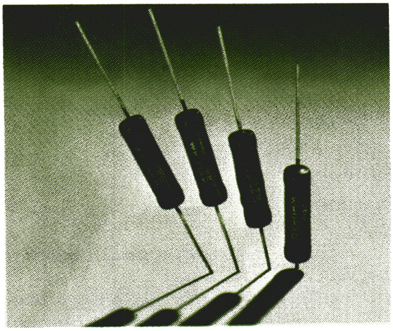


ΔT = temperature rise of resistor body.

——— lead length 25 mm
------- lead length 10 mm

fixed resistors

enamelled wirewound



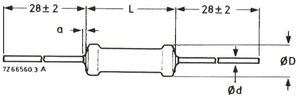
WR0617E WR0825E
WR0842E WR0865E

Status D

These resistors have a permissible hot-spot temperature of 400 °C. The leads are of a special material with high thermal resistance to counter temperature effects of the solder joint. The coating is a high quality vitreous enamel.

Resistance range	4,7 Ω to 100 kΩ E24 series	
Resistance tolerance	± 5%	
Max body temperature (hot spot)	400 °C	
Rated dissipation at T_{amb} = 70 °C	WR0617E	4,2 W
	WR0825E	7 W
	WR0842E	11 W
	WR0865E	17 W
Basic specification	IEC 266, type 2	
Climatic category (IEC 68)	55/200/56	
Stability after 1000 h max load	ΔR/R max 5%	

style	D_{max}	L_{max}	d	a_{max}
WR0617E	6	19	0,7	3
WR0825E	8	27	0,8	3
WR0842E	8	44	0,8	3
WR0865E	8	67	0,8	3



style	rated dissipation at T_{amb} = 70 °C W	resistance range Ω	catalogue no.
WR0617E	4,2	4,7 - 4 700	2322 330 22 . . . .
WR0825E	7	6,8 - 27 000	2322 330 32 . . .
WR0842E	11	10 - 56 000	2322 330 42 . . .
WR0865E	17	15 - 100 000	2322 330 52 . . .

Marking

Each resistor is marked with
resistance value (R for Ω, K for kΩ)
e.g. 27 Ω = 27R
27 kΩ = 27K

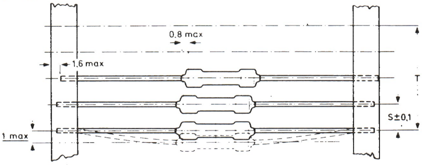
tolerance
style

Composition of the catalogue no.

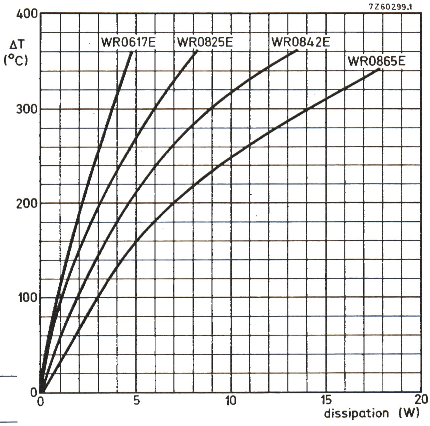
In the above-mentioned catalogue no. replace the first two dots by the first two digits of the resistance value. Replace the third dot by a figure according to the following table:

4,7 — 9,1 Ω: 8
10 — 91 Ω: 9
100 — 910 Ω: 1
1 000 — 9 100 Ω: 2
10 000 — 91 000 Ω: 3
100 000 Ω: 4

Configuration of reel



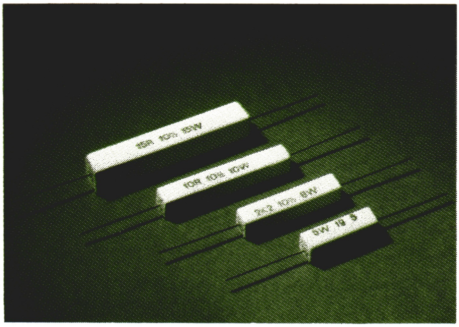
(1) For style WR0617E 5 mm.



ΔT = temperature rise of resistor body.

style	A	B1-B2 ± max	S	T for number (n) of resistors n ⩽ 50	50 < n ⩽ 100
WR0617E	66,7	1,2	10	10(n — 1) ± 2	10(n — 1) ± 4
WR0825E	74	1,2	10	10(n — 1) ± 2	10(n — 1) ± 4

rectangular wirewound



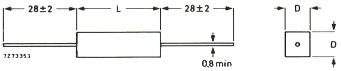
EH05 EH07
EH09 EH17

Status D

Resistors especially designed for high dissipation in a small volume. The rectangular package makes mounting quick and simple. Maximum hot-spot temperature of the resistors is 350 °C.

Resistance range	0,15 Ω to 22 kΩ E12 and E24 series
Resistance tolerance	± 5% or ± 10%
Max body temperature (hot spot)	350 °C
Rated dissipation at T_{amb} = 70 °C	EH05 5 W EH07 7 W EH09 9 W EH17 17 W
Basic specification	IEC 266
Climatic category (IEC 68)	40/200/56
Stability after 1000 h rated dissipation	ΔR/R max 5%

style	D_{max}	L_{max}
EH05	7,2	26
EH07	7,2	36
EH09	7,2	46
EH17	10,2	62



style	**rated dissipation at T_{amb} = 70 °C** **W**	resistance range Ω	tol. ± %	series	catalogue no.
EH05	**5**	0,15 – 8,2	10	E12	2306 330 02 . . .
		10 – 6800	5	E24	2306 330 03 . . .
EH07	**7**	0,27 – 8,2	10	E12	2306 331 02 . . .
		10 – 12 000	5	E24	2306 331 03 . . .
EH09	**9**	0,33 – 8,2	10	E12	2306 332 02 . . .
		10 – 15 000	5	E24	2306 332 03 . . .
EH17	**17**	0,47 – 8,2	10	E12	2306 333 02 . . .
		10 – 22 000	5	E24	2306 333 03 . . .

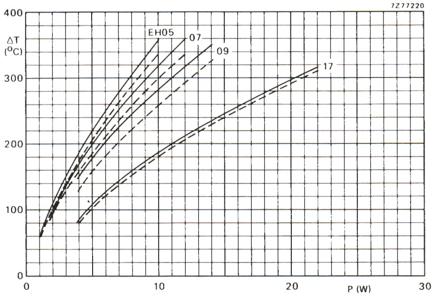
Marking

Each resistor is marked with resistance value (R for Ω, K for kΩ)
e.g. 27 Ω = 27R
15 kΩ = 15K
tolerance on resistance in ± %
rated dissipation at T_{amb} = 70 °C

Composition of the catalogue no.

In the above-mentioned catalogue no. replace the first two dots by the first two digits of the resistance value. Replace the third dot by a figure according to the following table:

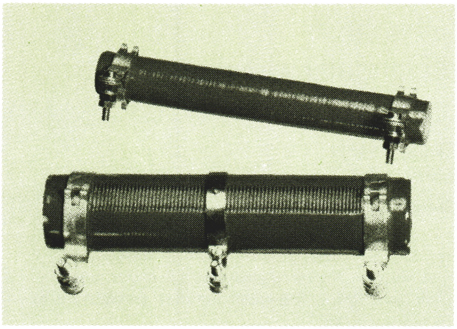
0,15 –	0,91 Ω	7
1 –	9,1 Ω	8
10 –	91 Ω	9
100 –	910 Ω	1
1 000 –	9 100 Ω	2
10 000 –	22 000 Ω	3



—— lead length 22 mm
---- lead length 28 mm
ΔT = temperature rise of resistor body.

fixed resistors

wirewound



2322 321 to 324
fixed or adjustable, with side terminals

Status D

Rated dissipation at T_{amb} = 40 °C	P, see table
mounted on metal plate	1,2 P
Temperature coefficient	–50 to +140 ppm/ °C
Climatic category IEC 68	55/155/56

P W	coating	resistance range	tolerance ± %	catalogue no. 2322 followed by fixed	 adjustable
8	cement	1 Ω – 100 Ω	10	323 14 . . .	-
		110 Ω – 150 Ω	5	323 34 . . .	-
	enamel	160 Ω – 6,8 kΩ	5	321 34 . . .	-
10	cement	1,2 Ω – 27 Ω	10	323 12 . . .	324 12 . . .
		30 Ω – 300 Ω	5	323 32 . . .	324 32 . . .
	enamel	330 Ω – 12 kΩ	5	321 32 . . .	-
		330 Ω – 3,3 kΩ	5	-	322 32 . . .
16	cement	1,5 Ω – 2,7 Ω	10	323 10 . . .	324 10 . . .
		3 Ω – 620 Ω	5	323 30 . . .	324 30 . . .
	enamel	680 Ω – 24 kΩ	5	321 30 . . .	-
		680 Ω – 6,8 kΩ	5	-	322 30 . . .
25	cement	2,7 Ω – 15 Ω	10	323 08 . . .	324 08 . . .
		16 Ω – 820 Ω	5	323 28 . . .	324 28 . . .
	enamel	1 kΩ – 39 kΩ	5	321 28 . . .	-
		1 kΩ – 9,1 kΩ	5	-	322 28 . . .
40	cement	4,7 Ω – 1,6 kΩ	5	323 26 . . .	324 26 . . .
	enamel	1,8 kΩ – 75 kΩ	5	321 26 . . .	-
		1,8 kΩ – 18 kΩ	5	-	322 26 . . .
60	cement	3 Ω – 2,2 kΩ	5	323 24 . . .	324 24 . . .
	enamel	2,4 kΩ – 68 kΩ	5	321 24 . . .	-
		2,4 kΩ – 24 kΩ	5	-	322 24 . . .
100	cement	6,8 Ω – 4,3 kΩ	5	323 23 . . .	324 23 . . .
	enamel	4,7 kΩ – 120 kΩ	5	321 23 . . .	-
		4,7 kΩ – 47 kΩ	5	-	322 23 . . .
160	cement	10 Ω – 47 kΩ	5	323 22 . . .	324 22 . . .
250	cement	16 Ω – 11 kΩ	5	323 21 . . .	324 21 . . .

Composition of the catalogue no.

2322 . . . .

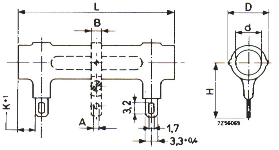
See table

The first two digits of the resistance value.

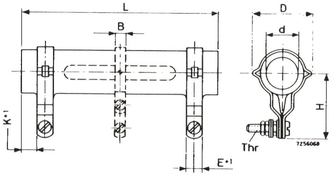
8 for R of 1 to 8,2 Ω
9 for R of 10 to 82 Ω
1 for R of 100 to 820 Ω
2 for R of 1 to 8,2 kΩ
3 for R of 10 to 82 kΩ
4 for R of 100 to 120 kΩ

P W	L_{max}	D_{max}	d_{min}	K	H	E	B	A	thread
8	26	11,5	5	2,5	14	-	-	-	-
10	41	11,5	4,2	4	14	-	5	2,8	-
16	62	11,5	4,2	4	14	-	5	2,8	-
25	64	16	7,2	4	20	-	6	3,2	-
40	103	16	7,2	4	20	-	6	3,2	-
60	103	32	12,5	6	33	8,5	6	-	M4
100	165	32	12,5	6	33	8,5	6	-	M4
160	165	44	20	8	40	10	8	-	M5
250	256	44	20	8	40	10	8	-	M5

P ⩽ 40 W



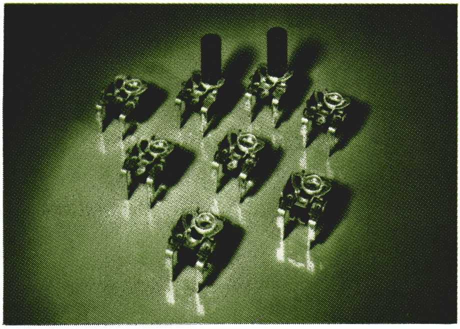
P ⩾ 60 W

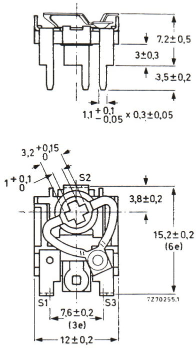


test switches

2422 136 7 . . . .

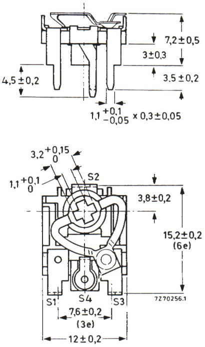
Status D





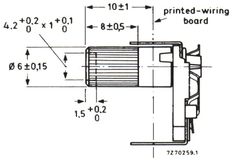
7,2±0,5
3±0,3
3,5±0,2
1,1 +0,1 −0,05 × 0,3±0,05
3,2 +0,15 0
1 +0,1 0
S2
3,8±0,2
15,2±0,2
(6e)
S1
S3
7,6±0,2
(3e)
12±0,2
7Z70255.1

Fig.1



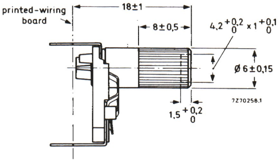
7,2±0,5
3±0,3
4,5±0,2
3,5±0,2
1,1 +0,1 −0,05 × 0,3±0,05
3,2 +0,15 0
1,1 +0,1 0
S2
3,8±0,2
15,2±0,2
(6e)
S1
S4
S3
7,6±0,2
(3e)
12±0,2
7Z70256.1

Fig.2



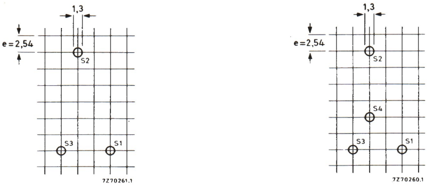
10±1
printed-wiring board
4,2 +0,2 0 × 1 +0,1 0
8±0,5
Ø 6±0,15
1,5 +0,2 0
7Z70259.1

Fig.3



printed-wiring board
18±1
8±0,5
4,2 +0,2 0 × 1 +0,1 0
Ø 6±0,15
1,5 +0,2 0
7Z70258.1

Fig.4



1,3
e=2,54
S2
S3
S1
7Z70261.1
1,3
e=2,54
S2
S4
S3
S1
7Z70260.1

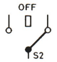
printed-wiring grids (solder side)

Composition of the catalogue no.

2422 136 7 . 33 .

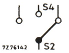
0 = without knob
1 = with knob at base-plate side (Fig.3)
2 = with knob at selector-contact side (Fig.4)

2 = with 2 active switch connections; with off-position (Fig.1)



4 = with 2 active switch connections; without off-position

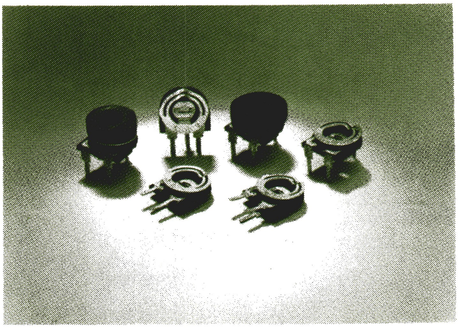
3 = with 3 active switch connections (Fig.2)



S4
S2
7Z76142

variable resistors

preset potentiometers



CTP10 – miniature carbon
10 mm – linear law

Status D

For detailed information
Handbook CM2a

Resistance range (E3-series), linear law	100 Ω – 4,7 MΩ
Max dissipation at T_{amb} = 40 °C	0,1 W
70 °C	0,05 W
Ambient temperature	–25 to +70 °C

Composition of the catalogue no.

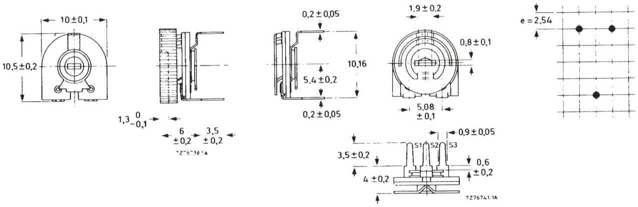
2322 410 . . . . .

0 = without knob
4 = with knob (2322 410 450 . . only)
cat. no. of knob: 4322 047 00190
6 = with knob (2322 410 611 . . and
2322 410 633 . . only)
cat. no. of knob: 4322 047 27740

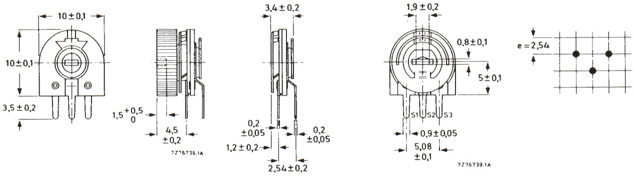
11 = vertical mounting
33 = horizontal mounting
50 = vertical mounting

nom value ± 20%	I_{max} slider mA	resistance code
100 Ω	10	51
220	7	52
330	6	69
470	4,5	53
1 kΩ	3,2	54
2,2	2,2	55
4,7	1,4	56
10	1,0	57
22	0,7	58
47	0,45	59
100	0,32	61
220	0,22	62
470	0,22	63
1 MΩ	0,22	64
2,2	0,22	65
4,7	0,14	66

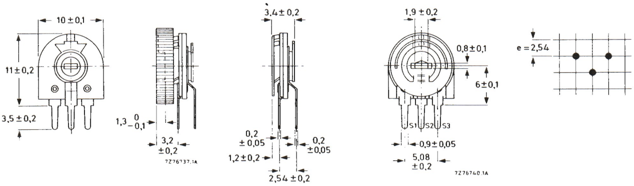
Horizontal mounting **33**


10±0,1
10,5±0,2
1,3 0 -0,1
6 ±0,2
3,5 ±0,2
7Z76738.1A
0,2±0,05
10,16
5,4±0,2
0,2±0,05
1,9±0,2
0,8±0,1
5,08 ±0,1
0,9±0,05
S1 S2 S3
3,5±0,2
0,6 ±0,2
4 ±0,2
7Z76741.1A
e=2,54

Vertical mounting **50**

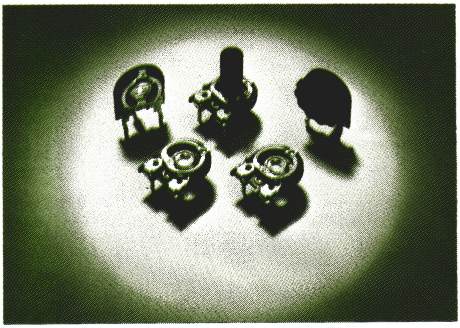

10±0,1
10±0,1
3,5±0,2
1,5 +0,5 0
4,5 ±0,2
7Z76736.1A
3,4±0,2
0,2 ±0,05
1,2±0,2
0,2 ±0,05
2,54±0,2
1,9±0,2
0,8±0,1
5±0,1
S1 S2 S3
0,9±0,05
5,08 ±0,1
7Z76739.1A
e=2,54

Vertical mounting **11**


10±0,1
11±0,2
3,5±0,2
1,3 0 -0,1
3,2 ±0,2
7Z76737.1A
3,4±0,2
0,2 ±0,05
1,2±0,2
0,2 ±0,05
2,54±0,2
1,9±0,2
0,8±0,1
6±0,1
S1 S2 S3
0,9±0,05
5,08 ±0,2
7Z76740.1A
e=2,54

CTP14 — carbon
14 mm — linear law

Status D



Resistance range	100 Ω to 4,7 MΩ
Max dissipation at T_{amb} = 40 °C	0,2 W
Operating temperature	–25 to +70 °C
Climatic category IEC 68	25/070/21
Basic specification	DIN 44150

Composition of the catalogue no.

2322 409 . . . . .

0 = without knob
1 = with knob at base-plate side
2 = with knob at carbon-track side
4 = with adjustment wheel at carbon-track side

horizontal mounting	
with snap-in pins	83
straight pins	63
vertical mounting	
with snap-in pins	72
straight pins	52

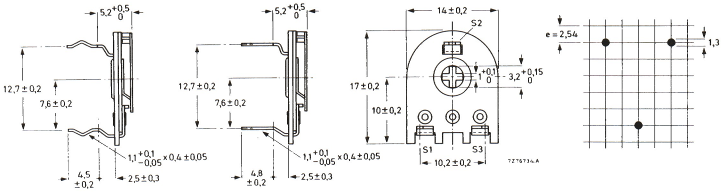
resistance code

nom value ± 20%	I_{max} slider mA	
100 Ω	45	51
220	30	52
330	24,5	69
470	20,5	53
1 kΩ	14	54
2,2	9,5	55
4,7	6,5	56
10	4,5	57
22	3	58
47	2	59
100	1,4	61
220	0,9	62
470	0,6	63
1 MΩ	0,4	64
2,2	0,3	65
4,7	0,2	66

Horizontal mounting

snap-in pins

straight pins

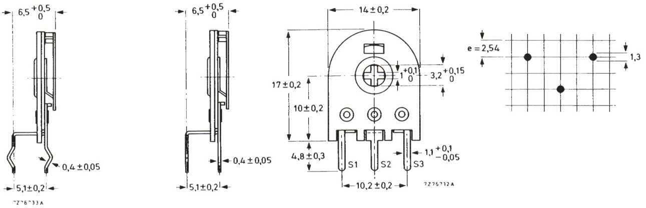


5,2 +0,5 0
12,7 ± 0,2
7,6 ± 0,2
1,1 +0,1 −0,05 × 0,4 ± 0,05
4,5 ± 0,2
2,5 ± 0,3
4,8 ± 0,2
14 ± 0,2
S2
17 ± 0,2
10 ± 0,2
1 +0,1 0
3,2 +0,15 0
S1
S3
10,2 ± 0,2
e = 2,54
1,3
7Z76734A

Vertical mounting

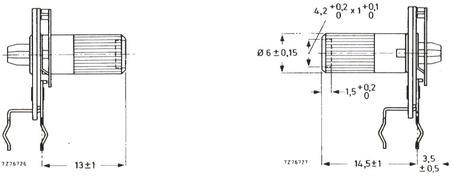
snap-in pins

straight pins



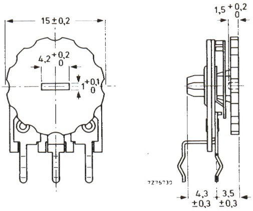
6,5 +0,5 0
0,4 ± 0,05
5,1 ± 0,2
7Z76733A
14 ± 0,2
17 ± 0,2
10 ± 0,2
1 +0,1 0
3,2 +0,15 0
4,8 ± 0,3
1,1 +0,1 −0,05
S1
S2
S3
10,2 ± 0,2
7Z76732A
e = 2,54
1,3

Knob



7Z76726
13 ± 1
4,2 +0,2 0 × 1 +0,1 0
Ø 6 ± 0,15
1,5 +0,2 0
7Z76727
14,5 ± 1
3,5 ± 0,5

Wheel sizes



15 ± 0,2
4,2 +0,2 0
1 +0,1 0
1,5 +0,2 0
7Z76730
4,3 ± 0,3
3,5 ± 0,3

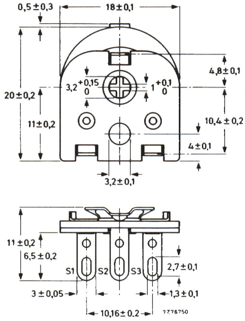
variable resistors

preset potentiometers

CTP18 — carbon
18 mm — linear law

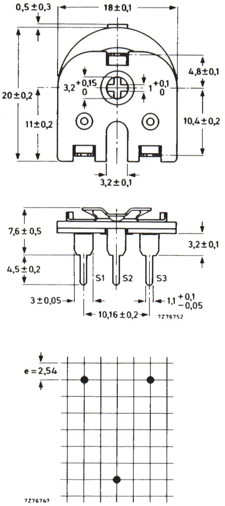
Status D

Resistance range (E3-series), linear law	100 Ω — 4,7 MΩ
Max dissipation at T_{amb} = 25 °C	0,25 W
70 °C	0,15 W
Operating temperature	−25 to +70 °C



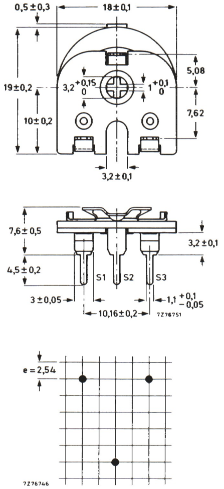
0,5±0,3
18±0,1
4,8±0,1
$3,2^{+0,15}_{0}$
$1^{+0,1}_{0}$
20±0,2
11±0,2
10,4 ± 0,2
4±0,1
3,2±0,1
11±0,2
6,5±0,2
S1
S2
S3
2,7±0,1
3±0,05
1,3±0,1
10,16± 0,2
7Z76750

Fig.1
2322 411 000 . .



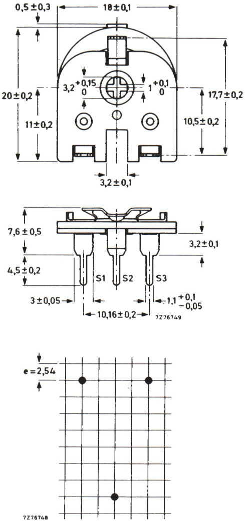
0,5±0,3
18±0,1
4,8±0,1
$3,2^{+0,15}_{0}$
$1^{+0,1}_{0}$
20±0,2
11±0,2
10,4±0,2
3,2±0,1
7,6 ± 0,5
3,2±0,1
4,5±0,2
S1
S2
S3
3±0,05
$1,1^{+0,1}_{-0,05}$
10,16 ±0,2
7Z76752
e = 2,54
7Z76747

Fig.2
2322 411 033 . .



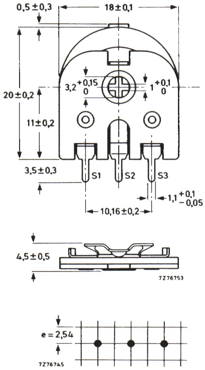
0,5±0,3
18±0,1
5,08
$3,2^{+0,15}_{0}$
$1^{+0,1}_{0}$
19±0,2
10±0,2
7,62
3,2±0,1
7,6±0,5
3,2±0,1
4,5±0,2
S1
S2
S3
3±0,05
$1,1^{+0,1}_{-0,05}$
10,16±0,2
7Z76751
e = 2,54
7Z76746

Fig.3
2322 411 083 . .



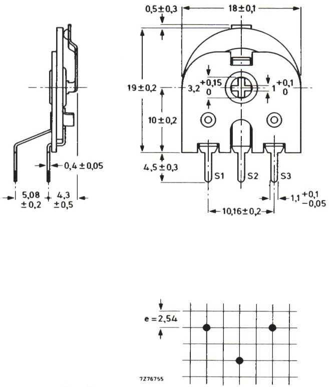
0,5±0,3
18±0,1
$3,2^{+0,15}_{0}$
$1^{+0,1}_{0}$
20±0,2
11±0,2
17,7±0,2
10,5±0,2
3,2±0,1
7,6±0,5
3,2±0,1
4,5±0,2
S1
S2
S3
3±0,05
$1,1^{+0,1}_{-0,05}$
10,16±0,2
7Z76749
e = 2,54
7Z76748

Fig.4
2322 411 084 . .



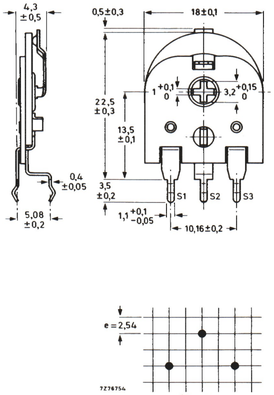
0,5±0,3
18±0,1
$3,2^{+0,15}_{0}$
$1^{+0,1}_{0}$
20±0,2
11±0,2
3,5±0,3
S1
S2
S3
$1,1^{+0,1}_{-0,05}$
10,16±0,2
4,5±0,5
7Z76753
e = 2,54
7Z76745

Fig.5
2322 411 022 . .



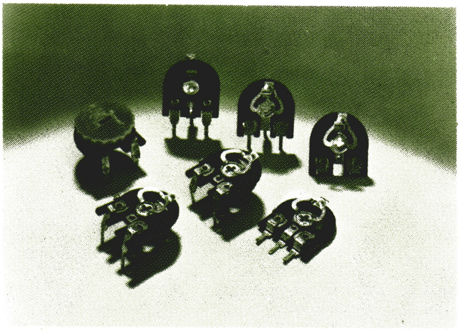
0,4±0,05
5,08
±0,2
4,3
±0,5
0,5±0,3
18±0,1
$3,2^{+0,15}_{0}$
$1^{+0,1}_{0}$
19±0,2
10±0,2
4,5±0,3
S1
S2
S3
$1,1^{+0,1}_{-0,05}$
10,16±0,2
e = 2,54
7Z76755

Fig.6
2322 411 072 . .



4,3
±0,5
0,4
±0,05
5,08
±0,2
0,5±0,3
18±0,1
$1^{+0,1}_{0}$
$3,2^{+0,15}_{0}$
22,5
±0,3
13,5
±0,1
3,5
±0,2
S1
S2
S3
$1,1^{+0,1}_{-0,05}$
10,16±0,2
e = 2,54
7Z76754

Fig.7
2322 411 073 . .



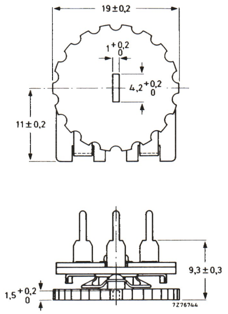

19 ± 0,2
1 +0,2 0
4,2 +0,2 0
11 ± 0,2
9,3 ± 0,3
1,5 +0,2 0
7Z76744

Fig.8
2322 411 433 . .

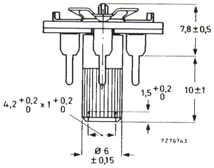

7,8 ± 0,5
10 ± 1
1,5 +0,2 0
4,2 +0,2 0 x 1 +0,2 0
Ø 6 ± 0,15
7Z76743

Fig.9
2322 411 133 . .

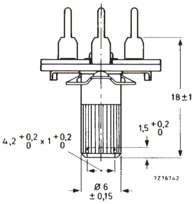

18 ± 1
1,5 +0,2 0
4,2 +0,2 0 x 1 +0,2 0
Ø 6 ± 0,15
7Z76742

Fig.10
2322 411 233 . .

Composition of the catalogue no.

2322 411 . . . . .

0 = without knob
1 = with knob at base-plate side
2 = with knob at carbon-track side
3 = with adjustment wheel at base-plate side
(only for vertical mounting versions)
4 = with adjustment wheel at carbon-track side

code for resistance value, see table

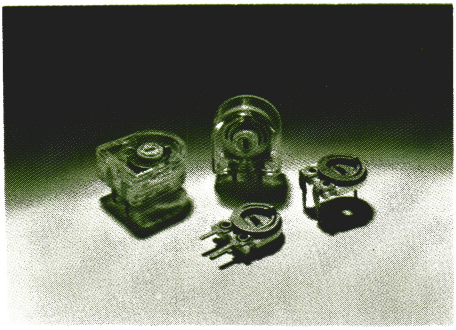
00 = with solder tags (Fig.1)
22 = with pins for vertical mounting (Fig.5)
33 = with pins for horizontal mounting (Fig.2, 8/10)
72 = with pins for vertical mounting
(according to DIN 44150, Fig.6)
73 = with pins for vertical mounting (Fig.7)
83 = with pins for horizontal mounting
(according to DIN 44150, Fig.3)
84 = with pins for horizontal mounting
(according to DIN 44151, Fig.4)

nom resistance value R_n	code in catalogue no.
100 Ω	51
220 Ω	52
330 Ω	69
470 Ω	53
1 kΩ	54
2,2 kΩ	55
4,7 kΩ	56
10 kΩ	57
22 kΩ	58
47 kΩ	59
100 kΩ	61
220 kΩ	62
470 kΩ	63
1 MΩ	64
2,2 MΩ	65
4,7 MΩ	66

Note: catalogue no. of adjustment wheel: 4322 047 08230;
catalogue no. of adjustment knob : 4322 047 08280.

variable resistors

preset potentiometers



TMP10 — cermet
10 mm — linear law
Status D

Max dissipation at T_{amb} = 70 °C	0,5 W
Operating temperature	−55 to +70 °C

Horizontal mounting

open version

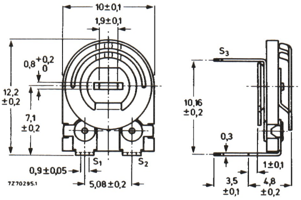

10±0,1
1,9±0,1
0,8 +0,2 0
12,2 ±0,2
7,1 ±0,2
0,9±0,05
5,08±0,2
S1
S2
S3
10,16 ±0,2
0,3
3,5 ±0,1
1±0,1
4,8 ±0,2
7Z70295.1

Fig.1a

dust-covered version

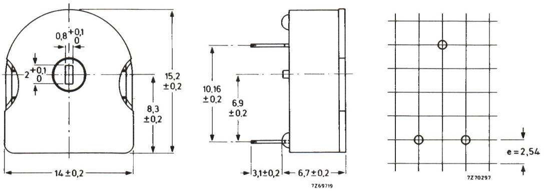

0,8 +0,1 0
2 +0,1 0
15,2 ±0,2
8,3 ±0,2
14±0,2
10,16 ±0,2
6,9 ±0,2
3,1±0,2
6,7±0,2
7Z69719
e = 2,54
7Z70297

Fig.1b

Vertical mounting

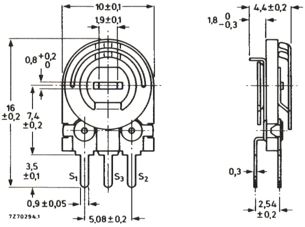

10±0,1
1,9±0,1
0,8 +0,2 0
16 ±0,2
7,4 ±0,2
3,5 ±0,1
S1
S3
S2
0,9±0,05
5,08±0,2
7Z70294.1
1,8 0 −0,3
4,4±0,2
0,3
2,54 ±0,2

Fig.2a

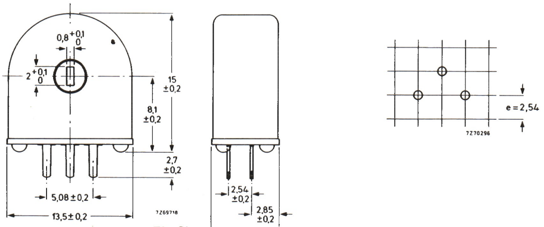

0,8 +0,1 0
2 +0,1 0
15 ±0,2
8,1 ±0,2
2,7 ±0,2
5,08±0,2
13,5±0,2
7Z69718
2,54 ±0,2
2,85 ±0,2
7,3±0,2
e = 2,54
7Z70296

Fig.2b

Composition of the catalogue no.

2322 482 . . . . .

code for version —— resistance code, see table

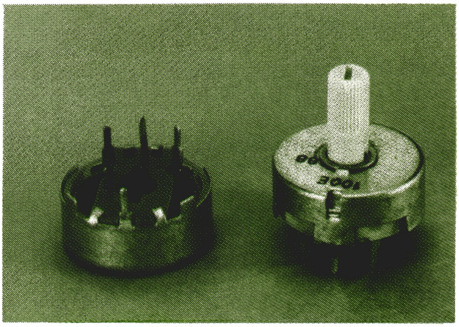
20 = for horizontal mounting (Fig.1a)
21 = dust-covered version for horizontal mounting (Fig.1b)
30 = for vertical mounting (Fig.2a)
31 = dust-covered version for vertical mounting (Fig.2b)

nominal resistance	code in catalogue no.
100 Ω	101
150 Ω	151
220 Ω	221
330 Ω	331
470 Ω	471
680 Ω	681
1 kΩ	102
1,5 kΩ	152
2,2 kΩ	222
3,3 kΩ	332
4,7 kΩ	472
6,8 kΩ	682

nominal resistance	code in catalogue no.
10 kΩ	103
15 kΩ	153
22 kΩ	223
33 kΩ	333
47 kΩ	473
68 kΩ	683
100 kΩ	104
150 kΩ	154
220 kΩ	224
330 kΩ	334
470 kΩ	474
680 kΩ	684
1 MΩ	105

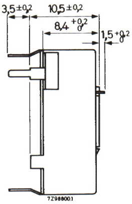
TWP22 — wirewound linear law

Status D

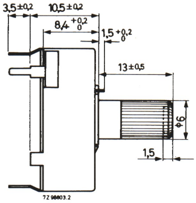


Maximum dissipation at T_{amb} = 40 °C		2 W
	70 °C	1,5 W
Operating temperature		−10 to + 70 °C
Climatic category (IEC 68)		10/070/21

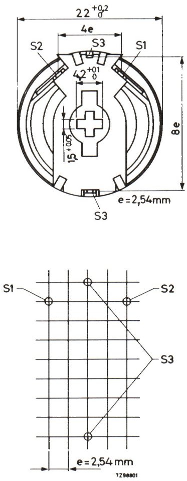
without knob


3,5±0,2
10,5±0,2
8,4 +0,2 0
1,5 +0,2 0
7Z98800.1

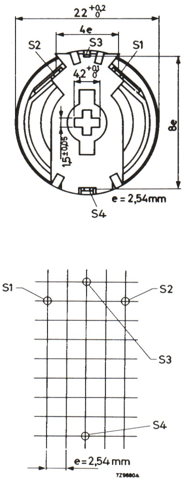
with knob


3,5±0,2
10,5±0,2
8,4 +0,2 0
1,5 +0,2 0
13±0,5
Φ6
1,5
7Z 98803.2

without tap


22 +0,2 0
4e
S2
S3
S1
4,2 +0,1 0
8e
1,5 +0,05
e = 2,54mm
S3
S1
S2
S3
e = 2,54 mm
7Z98801

with tap


22 +0,2 0
4e
S2
S3
S1
4,2 +0,1 0
8e
1,5±0,05
e = 2,54mm
S4
S1
S2
S3
S4
e = 2,54 mm
7Z98804

Composition of the catalogue no.

2322 011 . . . . .

resistance code, see table

without tap or knob = 02
with tap, without knob = 03
without tap, with knob = 22
with tap and knob = 23

resistance value in Ω	code in catalogue no.
2,2	228
3,3	338
4,7	478
6,8	688
10	109
15	159
22	229
33	339
47	479
68	689
100	101
120	121
150	151
180	181
220	221
330	331
470	471
680	681
1000	102
4700	472
11 + 11	229
50 + 50	101
150 + 150	301

variable resistors

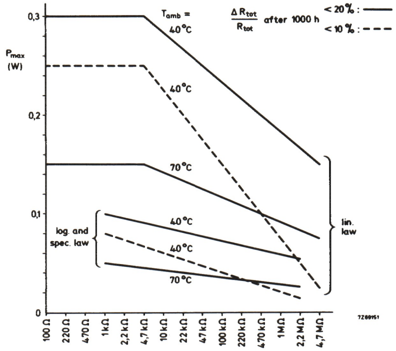
preset potentiometers

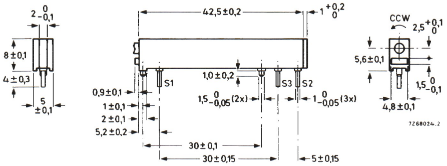
MCP10 MCP20 MCP40 – multiturn carbon 10, 20 and 40 turns – linear and other laws

Status D

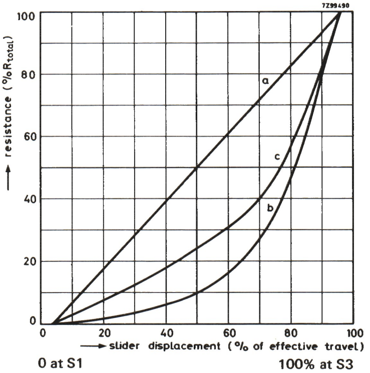
Precision multiturn preset potentiometers, widely used in tv and radio tuning.

Operating temperature	–25 to +70 °C
Climatic category IEC 68	25/070/21



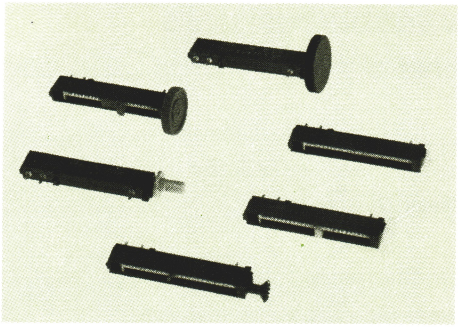


2 $_{-0,1}^{0}$
8 ±0,1
4 ±0,3
5 ±0,1
42,5 ±0,2
1 $_{0}^{+0,2}$
1,0 ±0,2
0,9 ±0,1
1 ±0,1
2 ±0,1
5,2 ±0,2
1,5 $_{-0,05}^{0}$ (2x)
1 $_{-0,05}^{0}$ (3x)
S1
S3
S2
30 ± 0,1
30 ± 0,15
5 ± 0,15
CCW
2,5 $_{0}^{+0,1}$
5,6 ±0,1
1,5 $_{-0,1}^{0}$
4,8 ±0,1
7Z68024.2



code in catalogue no.

nominal resistance	linear law, curve a	logarithmic law, curve b	special law, curve c
100 Ω	01		
220 Ω	02		
470 Ω	03		
1 kΩ	04	24	
2,2 kΩ	05	25	
4,7 kΩ	06	26	
10 kΩ	07	27	
22 kΩ	08	28	
47 kΩ	09	29	
100 kΩ	11	31	38
220 kΩ	12	32	
470 kΩ	13	33	
1 MΩ	14	34	
2,2 MΩ	15	35	
4,7 MΩ	16		



Composition of the catalogue no.

2322 41. . . . . .

code for number of turns of spindle
2 = 20 turns
3 = 10 turns
4 = 40 turns

resistance code, see table on previous page

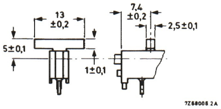
code for adjustment provision

code for indicator type

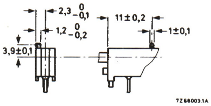
8 without indicator
but with dust cover

0 without indicator

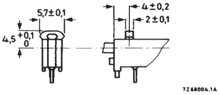
1


13
±0,2
5±0,1
1±0,1
7,4
±0,2
2,5±0,1
7Z68008.2A

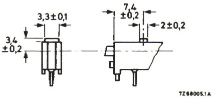
2


2,3 0 −0,1
1,2 0 −0,2
3,9±0,1
11±0,2
1±0,1
7Z68003.1A

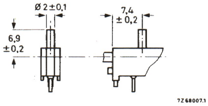
3


5,7±0,1
4,5 +0,1 0
4±0,2
2±0,1
7Z68004.1A

4

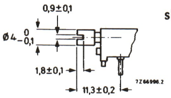

3,3±0,1
3,4
±0,2
7,4
±0,2
2±0,2
7Z68005.1A

5


Ø 2±0,1
6,9
±0,2
7,4
±0,2
7Z68007.1

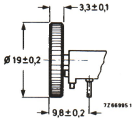
slotted

51


0,9±0,1
Ø 4 0 −0,1
1,8±0,1
11,3±0,2
7Z66996.2

knobs

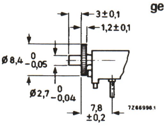
62


3,3±0,1
Ø 19±0,2
9,8±0,2
7Z66995.1

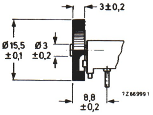
approx. 48 notches

gear-wheel

81

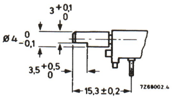

3±0,1
1,2±0,1
Ø 8,4 0 −0,05
Ø 2,7 0 −0,04
7,8
±0,2
7Z66998.1

61

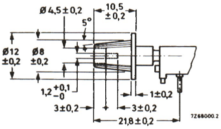

3±0,2
Ø 15,5
±0,1
Ø 3
±0,2
8,8
±0,2
7Z66999.1

approx. 60 notches

52

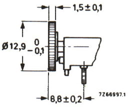

3 +0,1 0
Ø 4 0 −0,1
3,5 +0,5 0
15,3±0,2
7Z68002.4

64


Ø 4,5±0,2
10,5
±0,2
5°
Ø 12
±0,2
Ø 8
±0,2
1,2 +0,1 −0
1±0,2
3±0,2
3±0,2
21,8±0,2
7Z68000.2

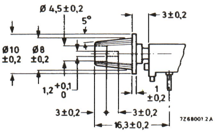
gear-wheel

82

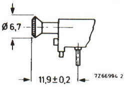

1,5±0,1
Ø 12,9 0 −0,1
8,8±0,2
7Z66997.1

gear-wheel

63


Ø 4,5±0,2
5°
3±0,2
Ø 10
±0,2
Ø 8
±0,2
1,2 +0,1 0
1
±0,2
3±0,2
3±0,2
16,3±0,2
7Z68001.2A

83


Ø 6,7
11,9±0,2
7Z66994.2

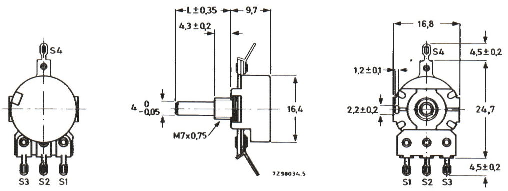
variable resistors

control potentiometers

CP16 — carbon
16 mm — linear and other laws
Status D

Widely used in video and audio equipment.

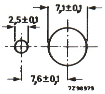
Max dissipation at T_{amb} = 40 °C	
linear	0,1 W
others	0,05 W
Operating temperature	−10 to +70 °C
Climatic category IEC 68	10/070/21
Breaking capacity of switch	
rotary	12 V(d.c.), 2A
push-pull	250 V(a.c.), 1A


S4
S3 S2 S1
L±0,35
9,7
4,3±0,2
4 0 −0,05
16,4
M7x0,75
7Z98034.5
16,8
S4
4,5±0,2
1,2±0,1
2,2±0,2
24,7
4,5±0,2
S1 S2 S3

Single potentiometer

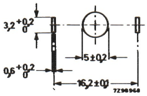
Mounting facilities
required mounting holes in chassis.

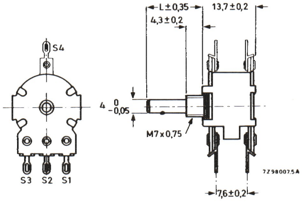
mounting bush
M7 x 0,75


2,5±0,1
7,1±0,1
7,6±0,1
7Z98979

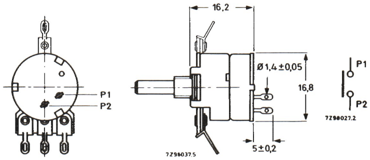
twist tags

Note: not for potentiometers with push-pull switch.

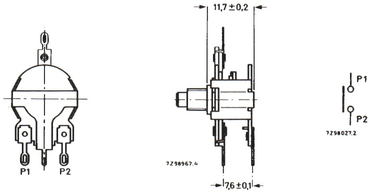

3,2 +0,2 0
0,6 +0,2 0
5±0,2
16,2±0,1
7Z98968


L±0,35
13,7±0,2
4,3±0,2
S4
4 0 −0,05
M7x0,75
S3 S2 S1
7Z98007.5A
7,6±0,2

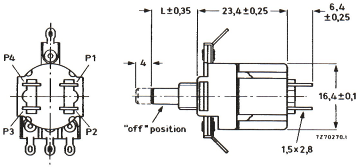
Tandem potentiometer

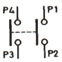

16,2
Ø1,4±0,05
16,8
P1
P2
P1
P2
7Z98037.5
5±0,2
7Z98027.2

Single potentiometer with s.p.s.t. rotary switch (spring actuated).

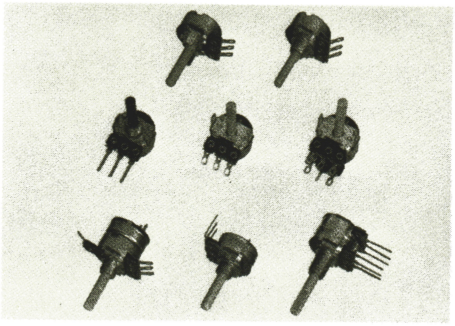

11,7±0,2
P1
P2
P1
P2
7Z98967.4
7Z98027.2
7,6±0,1

Single potentiometer with s.p.s.t. rotary switch (direct operating).

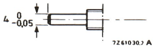

L±0,35
23,4±0,25
6,4 ±0,25
P4
P1
4
16,4±0,1
P3
P2
"off" position
7Z70270.1
1,5x2,8



Single potentiometer with d.p.s.t. push-pull switch.

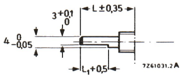


Spindles



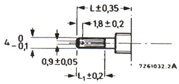
4 $^{0}_{-0,05}$
7Z61030.2 A

plain



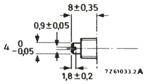
3 $^{+0,1}_{0}$
L ±0,35
4 $^{0}_{-0,05}$
L₁+0,5
7Z61031.2A

flat-faced



L ±0,35
1,8 ±0,2
4 $^{0}_{-0,1}$
0,9 ±0,05
L₁ ±0,2
7Z61032.2A

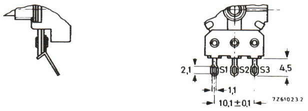
knurled



8 ±0,35
0,9 ±0,05
4 $^{0}_{-0,05}$
1,8 ±0,2
7Z61033.2A

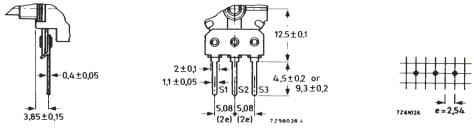
slotted

Connecting terminals



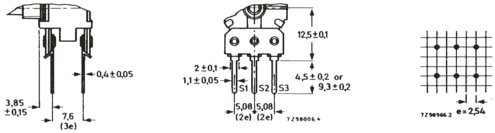
2,1
S1
S2
S3
4,5
1,1
10,1 ±0,1
7Z61023.2

Solder tags



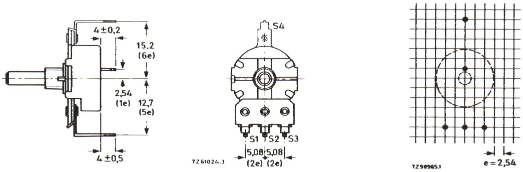
0,4 ±0,05
3,85 ±0,15
12,5 ±0,1
2 ±0,1
1,1 ±0,05
S1
S2
S3
4,5 ±0,2 or
9,3 ±0,2
5,08 (2e)
5,08 (2e)
7Z98038.4
7Z61026
e = 2,54

Long or short printed-wiring pins (single potentiometer)



0,4 ±0,05
3,85 ±0,15
7,6 (3e)
12,5 ±0,1
2 ±0,1
1,1 ±0,05
S1
S2
S3
4,5 ±0,2 or
9,3 ±0,2
5,08 (2e)
5,08 (2e)
7Z98006.4
7Z98966.2
e = 2,54

Long or short printed-wiring pins (tandem potentiometer)



4 ±0,2
15,2 (6e)
2,54 (1e)
12,7 (5e)
4 ±0,5
S4
S1
S2
S3
5,08 (2e)
5,08 (2e)
7Z61024.3
7Z98965.1
e = 2,54

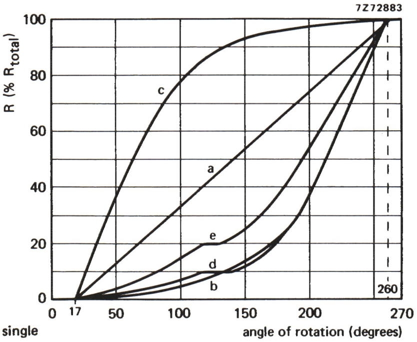
Bent printed-wiring pins

variable resistors

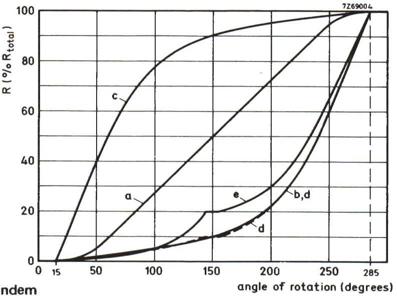
control potentiometers

CP16 — carbon
16 mm — linear and other laws

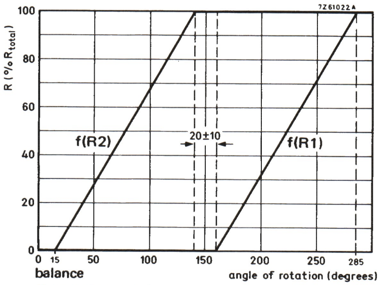
Status D



single



tandem



balance
(for tandem only)

code in catalogue no.

nominal resistance	linear law curve a	log. law curve b	rev. log. law curve c	balance curve f
220 Ω	02			
470 Ω	03			
1 kΩ	04	24	44	
2,2 kΩ	05	25	45	
4,7 kΩ	06	26	46	
10 kΩ	07	27	47	91
22 kΩ	08	28	48	92
47 kΩ	09	29	49	93
100 kΩ	11	31	51	94
220 kΩ	12	32	52	95
470 kΩ	13	33	53	96
1 MΩ	14	34	54	97
2,2 MΩ	15	35	55	
4,7 MΩ	16			

code in catalogue no.

nominal resistance	tap at 10% curve d	tap at 20% curve e
5 + 42 kΩ	72	
20 + 200 kΩ	67	
50 + 420 kΩ	73	
100 + 900 kΩ	64	
2 + 8 kΩ		76
5 + 17 kΩ		82
10 + 37 kΩ		86
20 + 80 kΩ		77
50 + 170 kΩ		83
100 + 370 kΩ		87
0,5 + 1,7 MΩ		84

Composition of the catalogue no. 2322 . . . .

code for type and switch, see table below

code for terminals, mounting facility, spindle type and length L

code for resistance law and nominal resistance, see table previous page

solder tags

mounting bushing		twist tags	
steel spindle	plastic spindle	steel spindle	plastic spindle
0 . .	7 . .	2 . .	4 . .

p.w. pins, length 4,5 mm

mounting bushing		twist tags	
steel spindle	plastic spindle	steel spindle	plastic spindle
0 . .	7 . .	2 . .	4 . .

p.w. pins, length 9,3 mm

mounting bushing		twist tags	
steel spindle	plastic spindle	steel spindle	plastic spindle
1 . .	6 . .	3 . .	5 . .

L =	10 mm = . 11	
	12 mm = . 09	
	15 mm = . 12	
	17 mm = . 13	
	19 mm = . 14	
plain	20 mm = . 15	
	22 mm = . 17	
	24 mm = . 19	
	25 mm = . 01	
	28 mm = . 02	
	30 mm = . 03	
	10 mm = . 42	(L_1 = 3,5 mm)
flat	15 mm = . 44	(L_1 = 8,5 mm)
faced	20 mm = . 45	(L_1 = 8,5 mm)
	20 mm = . 46	(L_1 = 13,5 mm)
knurled	10 mm = . 26	(L_1 = 5 mm)
(plastic	15 mm = . 27	(L_1 = 9 mm)
only)	20 mm = . 28	(L_1 = 9 mm)
slotted	= . 10	

L =	10 mm = . 61	
	12 mm = . 59	
	15 mm = . 62	
	17 mm = . 63	
	19 mm = . 64	
plain	20 mm = . 65	
	22 mm = . 67	
	24 mm = . 69	
	25 mm = . 51	
	28 mm = . 52	
	30 mm = . 53	
	10 mm = . 92	(L_1 = 3,5 mm)
flat	15 mm = . 94	(L_1 = 8,5 mm)
faced	20 mm = . 95	(L_1 = 8,5 mm)
	20 mm = . 96	(L_1 = 13,5 mm)
knurled	10 mm = . 76	(L_1 = 5 mm)
(plastic	15 mm = . 77	(L_1 = 9 mm)
only)	20 mm = . 78	(L_1 = 9 mm)
slotted	= . 60	

Code for type and switch

without switch	single	= 380
	single, with bent p.w. pins (only available with mounting bushing and p.w. pins of 9,3 mm length)	= 389
	tandem (and balance)	= 390
with switch	single, with s.p.s.t. rotary switch, spring actuated (only available with mounting bushing)	= 381
	single, with d.p.s.t. push-pull switch (only available with mounting bushing and plastic spindle, not available with slotted spindle)	= 382
	single, with s.p.s.t. rotary switch, direct operating (plastic spindle only)	= 387

variable resistors

control potentiometers

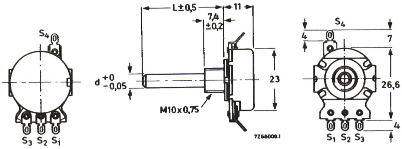
CP23 – carbon
23 mm – linear and other laws

Status D

Widely used in video and audio equipment.

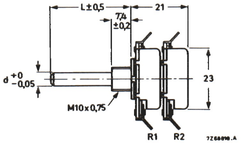
Max dissipation at T_{amb} = 40 °C	
linear	0,25 W
others	0,125 W
Working temperature	– 10 to +70 °C
Climatic category IEC 68	10/070/21
Breaking capacity of switch	250 V (a.c.)

Potentiometers



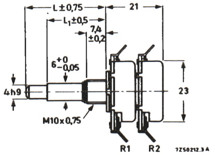
S4
S3 S2 S1
L±0,5
11
7,4 ±0,2
d +0 −0,05
23
M10x0,75
7Z68009.1
4
7
26,6
4
S1 S2 S3

Single



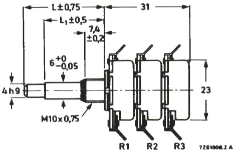
L±0,5
21
7,4 ±0,2
d +0 −0,05
23
M10x0,75
R1
R2
7Z68010.A

Tandem



L±0,75
L1±0,5
21
7,4 ±0,2
6 +0 −0,05
4h9
23
M10x0,75
R1
R2
7Z50212.3A

Twin

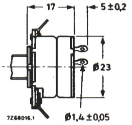


L±0,75
L1±0,5
31
7,4 ±0,2
6 +0 −0,05
4h9
23
M10x0,75
R1
R2
R3
7Z61008.2A

Triple

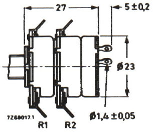
For d, L and L_1 see composition of catalogue no.

Switches



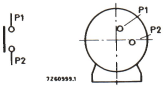
17
5±0,2
ø23
ø1,4±0,05
7Z68016.1

S.P.S.T. rotary
switch (single)

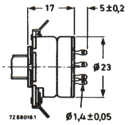


27
5±0,2
ø23
ø1,4±0,05
R1
R2
7Z68017.1

S.P.S.T. rotary
switch (tandem or twin)

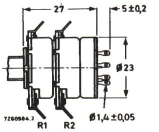


P1
P2
P1
P2
7Z60999.1



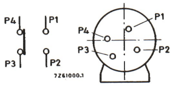
17
5±0,2
ø23
ø1,4±0,05
7Z68018.1

S.P.D.T. rotary
switch (single)

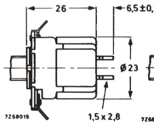


27
5±0,2
ø23
ø1,4±0,05
R1
R2
7Z60984.2

S.P.D.T. rotary
switch (tandem)

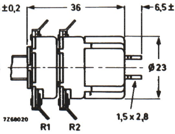


P4
P1
P3
P2
P1
P4
P3
P2
7Z61000.1



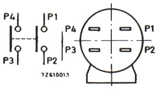
26
6,5±0,2
ø23
1,5x2,8
7Z68019

D.P.S.T. rotary
switch (single)

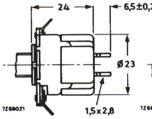


36
6,5±0,2
ø23
1,5x2,8
R1
R2
7Z68020

D.P.S.T. rotary
switch (tandem or twin)

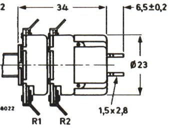


P4
P1
P3
P2
P4
P1
P3
P2
7Z61001.1



24
6,5±0,2
ø23
1,5x2,8
7Z68021

D.P.S.T. push-pull
switch (single)

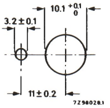


34
6,5±0,2
ø23
1,5x2,8
R1
R2
7Z68022

D.P.S.T. push-pull
switch (tandem or twin)

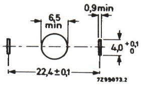
Required mounting holes in chassis

mounting bushing
M10 x 0,75

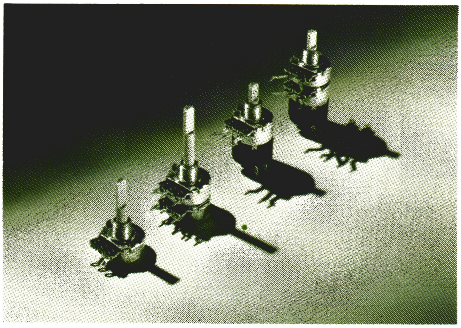


10.1 +0.1 0
3.2±0.1
11±0.2
7Z98028.1

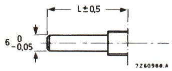
twist tags
only for single
and tandem



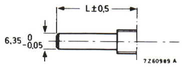
0,9min
6,5 min
4,0 +0,1 0
22,4±0,1
7Z99073.2



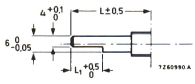
Spindles


L±0,5
6 0 −0,05
7Z60988.A

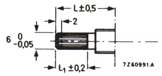
plain


L±0,5
6,35 0 −0,05
7Z60989.A

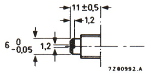
plain


4 +0,1 0
L±0,5
6 0 −0,05
L1 +0,5 0
7Z60990.A

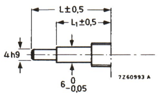
flat faced


L±0,5
2
6 0 −0,05
L1 ±0,2
7Z60991.A

knurled

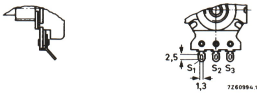

11±0,5
1,2
6 0 −0,05
1,2
7Z60992.A

slotted

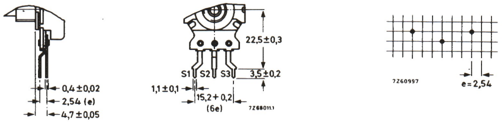

L±0,5
L1±0,5
4h9
6 0 −0,05
7Z60993.A

twin/triple

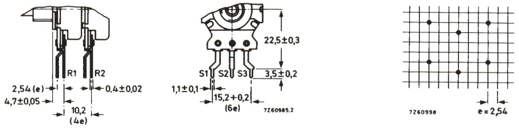
Connecting terminals


2,5
S1
S2 S3
1,3
7Z60994.1

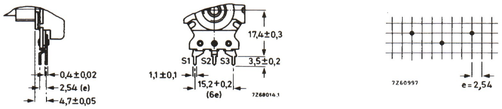
Solder tags


0,4±0,02
2,54 (e)
4,7±0,05
22,5±0,3
S1 S2 S3
3,5±0,2
1,1±0,1
15,2+0,2
(6e)
7Z68011.1
7Z60997
e=2,54

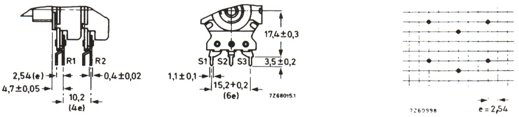
Long printed-wiring pins, pin distance 15,2 mm (6e) (single potentiometer).


R1
R2
2,54 (e)
4,7±0,05
0,4±0,02
10,2
(4e)
22,5±0,3
S1 S2 S3
3,5±0,2
1,1±0,1
15,2+0,2
(6e)
7Z60985.2
7Z60998
e=2,54

Long printed-wiring pins, pin distance 15,2 mm (6e) (tandem potentiometer).


0,4±0,02
2,54 (e)
4,7±0,05
17,4±0,3
S1 S2 S3
3,5±0,2
1,1±0,1
15,2+0,2
(6e)
7Z68014.1
7Z60997
e=2,54

Short printed-wiring pins, pin distance 15,2 mm (6e) (single potentiometer).


R1
R2
2,54 (e)
4,7±0,05
0,4±0,02
10,2
(4e)
17,4±0,3
S1 S2 S3
3,5±0,2
1,1±0,1
15,2+0,2
(6e)
7Z68015.1
7Z60998
e=2,54

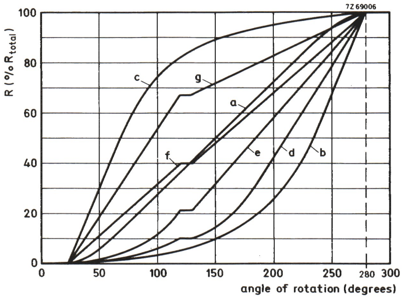
Short printed-wiring pins, pin distance 15,2 mm (6e) (tandem potentiometer).

variable resistors

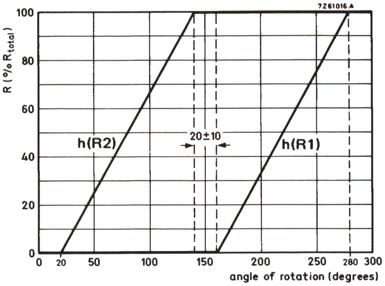
control potentiometers

CP23 – carbon
23 mm – linear and other laws

Status D



single and tandem



balance (tandem only)

code in catalogue no.

nominal resistance	linear law curve a	log. law curve b	rev. log. law curve c	balance curve h
220 Ω	02			
330 Ω	19		59	
470 Ω	03		43	
1 kΩ	04	24	44	
2,2 kΩ	05	25	45	
4,7 kΩ	06	26	46	
10 kΩ	07	27	47	
22 kΩ	08	28	48	92
47 kΩ	09	29	49	93
100 kΩ	11	31	51	94
220 kΩ	12	32	52	95
470 kΩ	13	33	53	96
1 MΩ	14	34	54	97
2,2 MΩ	15	35	55	
4,7 MΩ	16	36		

code in catalogue no.

nominal resistance	tap at 10% curve d	tap at 20% curve e	tap at 40% curve f	tap at 67% curve g
20 + 200 kΩ	67			
50 + 420 kΩ	73			
100 + 900 kΩ	64			
0,2 + 2 MΩ	68			
0,5 + 1,7 kΩ		81		
5 + 17 kΩ		82		
10 + 37 kΩ		86		
20 + 80 kΩ		77		
50 + 170 kΩ		83		
100 + 370 kΩ		87		
200 + 800 kΩ		78		
0,5 + 1,7 MΩ		84		
400 + 600 kΩ			89	
200 + 100 kΩ				65

Composition of the catalogue no.
Single and tandem types

2322 ... .

code for type and switch

code for terminals, mounting facility, type, and length of plastic spindle

code for resistance law and nominal resistance, see table previous page

code for type and switch	
without switch	
single = 350	tandem = 360
with s.p.d.t. rotary switch	
single = 352	tandem = 363
with s.p.s.t. rotary switch	
single = 353	tandem = 362
with d.p.s.t. push-pull switch 2A	
single = 355	tandem = 365
with d.p.d.t. rotary switch	
single = 357	tandem = 366

solder tags

mounting bushing 7 . . type	length	
plain ϕ 6 mm	17 mm	= 713
	18 mm	= 706
	19 mm	= 714
	20 mm	= 715
	22 mm	= 717
	25 mm	= 701
	30 mm	= 703
	35 mm	= 704
	40 mm	= 705
	60 mm	= 707
	70 mm	= 708
	90 mm	= 709
flat faced	18 mm	= 740
	25 mm	= 741
	28 mm	= 742
	30 mm	= 743
	35 mm	= 744
	40 mm	= 745
	60 mm	= 747
	70 mm	= 748
	90 mm	= 749

twist tags 4 . . type	length	
plain ϕ 6,35 mm	17 mm	= 433
	18 mm	= 426
	19 mm	= 434
	20 mm	= 435
	22 mm	= 437
	25 mm	= 421
	30 mm	= 423
	35 mm	= 424
	40 mm	= 425
	60 mm	= 427
	70 mm	= 428
	90 mm	= 429
knurled	18 mm	= 411
	30 mm	= 412
	60 mm	= 431
slotted		= 410

long p.w. pins

mounting bushing 3 . . / twist tags 5 . . type	length	
plain ϕ 6 mm	17 mm	= . 63
	18 mm	= . 56
	19 mm	= . 64
	20 mm	= . 65
	22 mm	= . 67
	25 mm	= . 51
	30 mm	= . 53
	35 mm	= . 54
	40 mm	= . 55
	60 mm	= . 57
	70 mm	= . 58
	90 mm	= . 59
flat faced	18 mm	= . 90
	25 mm	= . 91
	28 mm	= . 92
	30 mm	= . 93
	35 mm	= . 94
	40 mm	= . 95
	60 mm	= . 97
	70 mm	= . 98
	90 mm	= . 99

short p.w. pins

mounting bushing 2 . . / twist tags 6 . . type	length	
plain ϕ 6,35 mm	17 mm	= . 83
	18 mm	= . 76
	19 mm	= . 84
	20 mm	= . 85
	22 mm	= . 87
	25 mm	= . 71
	30 mm	= . 73
	35 mm	= . 74
	40 mm	= . 75
	60 mm	= . 77
	70 mm	= . 78
	90 mm	= . 79
knurled	18 mm	= . 61
	30 mm	= . 62
	70 mm	= . 81
slotted		= . 60

Composition of the catalogue no.
Twin and triple types

2322 ... .

code for type, switch and hollow spindle

code for resistance law and nominal resistance of potentiometer R_2, see table previous page

code for resistance law and nominal resistance of potentiometer R_1, see table previous page

code for spindle lengths

steel hollow spindle		plastic hollow spindle	
without switch		without switch	
twin = 370	triple = 378	twin = 470	triple = 478
with s.p.d.t. rotary switch		with s.p.d.t. rotary switch	
twin = 372		twin = 472	
with s.p.s.t. rotary switch		with s.p.s.t. rotary switch	
twin = 373		twin = 473	
with d.p.s.t. push-pull switch 2A		with d.p.s.t. push-pull switch 2A	
twin = 375		twin = 475	
with d.p.s.t. rotary switch		with d.p.s.t. rotary switch	
twin = 376		twin = 476	

steel hollow spindle	plastic hollow spindle
18 and 30,5 mm = 6	18 and 30,5 mm = 0
30 and 42,5 mm = 7	30 and 42,5 mm = 1

variable resistors

control potentiometers

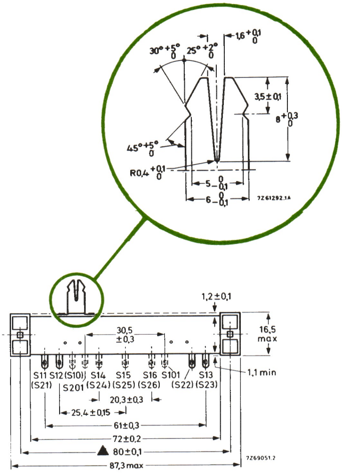
SLP60 — slide carbon
60 mm — linear and other laws

Status D

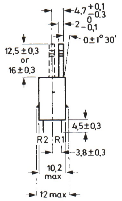
Widely used in video and audio equipment.

Max dissipation at T_{amb} = 40 °C	
linear	0,4 W
others	0,2 W
Operating temperature	– 10 to +70 °C
Climatic category IEC 68	10/070/21

Additional terminals for tandem are shown in brackets.

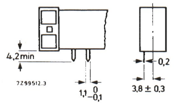


30° +5° 0
25° +2° 0
1,6 +0,1 0
3,5 ± 0,1
8 +0,3 0
45° +5° 0
R0,4 +0,1 0
5 – 0 0,1
6 – 0 0,1
7Z61292.1A
1,2 ± 0,1
16,5 max
30,5 ± 0,3
1,1 min
S11 S12 (S10) S14 S15 S16 S101 S13
(S21) S201 (S24) (S25) (S26) (S22) (S23)
20,3 ± 0,3
25,4 ± 0,15
61 ± 0,3
72 ± 0,2
▲ 80 ± 0,1
87,3 max
7Z69051.2



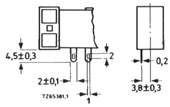
4,7 +0,1 –0,3
2 – 0 0,1
0 ± 1° 30'
12,5 ± 0,3 or 16 ± 0,3
4,5 ± 0,3
R2 R1
3,8 ± 0,3
10,2 max
12 max

printed-wiring pins



4,2min
0,2
7Z99512.3
1,1 0 –0,1
3,8 ± 0,3

solder tags

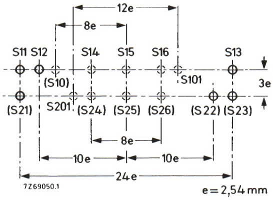


4,5 ± 0,3
2
0,2
2 ± 0,1
1
7Z65381.1
3,8 ± 0,3

▲78,0 ± 0,1 for mounting with screws M3.

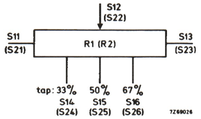
marking is always placed at the beginning of R1 (S11)

holes:
(viewed on component side)

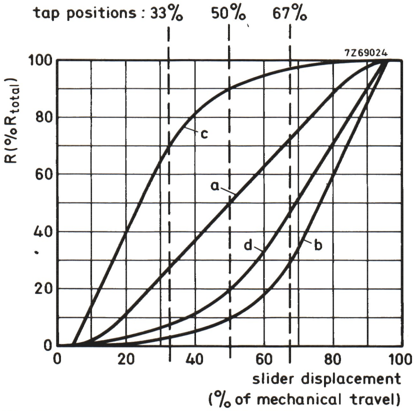


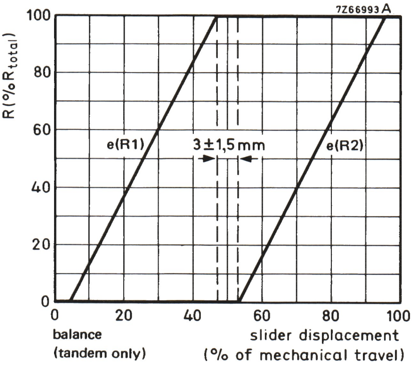
12e
8e
S11 S12 S14 S15 S16 S13
(S10)
S101
3e
(S21) S201 (S24) (S25) (S26) (S22) (S23)
8e
10e
10e
24e
7Z69050.1
e = 2,54 mm

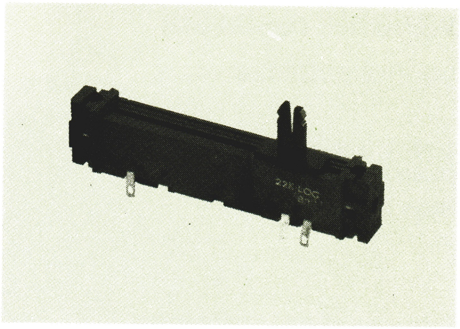
earthing screen
S101; S201 external
S10 internal



S12 (S22)
S11 (S21)
R1 (R2)
S13 (S23)
tap: 33% 50% 67%
S14 S15 S16
(S24) (S25) (S26)
7Z69026







Composition of the catalogue no. 2322 42 . . . . .

single code for mounting facility
- 0 = no mounting facility
- 1 = making use of holes in top and bottom
- 2 = making use of holes in the small sides
- 3 = making use of holes in front and back
- **4 = mounting with self-tapping Parker screws**

1, 2, 3 mounting with screws

tandem
- 5 = no mounting facility
- 6 = making use of holes in top and bottom
- 7 = making use of holes in the small sides
- 8 = making use of holes in front and back
- **9 = mounting with self-tapping Parker screws**

6, 7, 8 mounting with screws

code for resistance law and nominal resistance, see table below

code for taps
- 0 = without taps
- 1 = tap at 1/3
- 2 = tap at 1/2
- 4 = taps at 1/3 and 2/3

code for terminals and screening

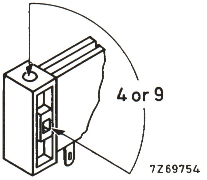
with solder tags:
- 0 = without screening
- 1 = with internal screening*
- 2 = with internal and external screening*
- 3 = with external screening

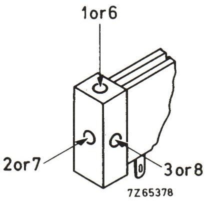
with printed-wiring pins:
- 5 = without screening
- 6 = with internal screening*
- 7 = with internal and external screening*
- 8 = with external screening

code for adjustment provision

length 12,5 mm:
- 0 = asymmetrically placed
- 1 = symmetrically placed

length 16 mm:
- 2 = asymmetrically placed
- 3 = symmetrically placed





* Only for tandem potentiometers.

code in catalogue no.

nominal resistance	linear law	log. law	rev. log. law without tap, or with tap at 1/3 of the total travel	semi-log. law	balance without tap only
	curve a	curve b	curve c	curve d	curve e
220 Ω	02				
330 Ω	19				
470 Ω	03			63	
1 kΩ	04	24	44	64	
2,2 kΩ	05	25	45	65	
4,7 kΩ	06	26	46	66	
10 kΩ	07	27	47	67	87
22 kΩ	08	28	48	68	88
47 kΩ	09	29	49	69	89
100 kΩ	11	31	51	71	91
220 kΩ	12	32	52	72	92
470 kΩ	13	33	53	73	93
1 MΩ	14	34	54	74	94
2,2 MΩ	15	35	55	75	95
4,7 MΩ	16	36	56	76	96
10 MΩ	17				

variable resistors

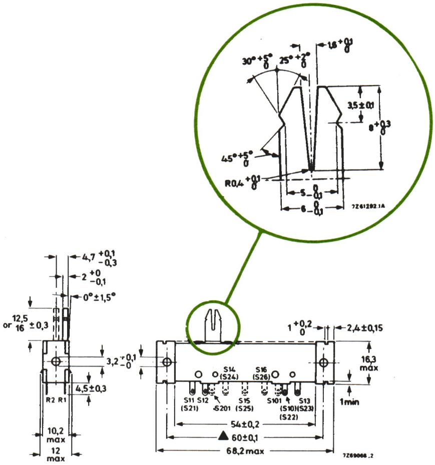
control potentiometers

SLP40 — slide carbon
40 mm — linear and other laws

Status D

Widely used in video and audio equipment.

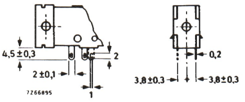
Max dissipation at T_{amb} = 40 °C	
linear	0,25 W
others	0,125 W
Operating temperature	−10 to +70 °C
Climatic category IEC 68	10/070/21


30° +5° 0
25° +2° 0
1,6 +0,1 0
3,5 ± 0,1
8 +0,3 0
45° +5° 0
R0,4 +0,1 0
5 0 −0,1
6 0 −0,1
7Z61292.1A
4,7 +0,1 −0,3
2 +0 −0,1
0° ± 1,5°
or 12,5 16 ± 0,3
3,2 +0,1 −0
4,5 ± 0,3
R2 R1
10,2 max
12 max
1 +0,2 0
2,4 ± 0,15
16,3 max
1 min
S14 (S24)
S16 (S26)
S11 (S21)
S12
S201
S15 (S25)
S101
(S10)(S22)
S13 (S23)
54 ± 0,2
▲ 60 ± 0,1
68,2 max
7Z69068.2

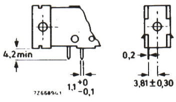
▲62,0 ± for mounting with self-tapping Parker screws.

Additional terminals for tandem
are shown in brackets.

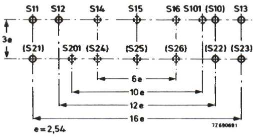
printed-wiring pins


4,5 ± 0,3
2
2 ± 0,1
1
7Z66895
0,2
3,8 ± 0,3
3,8 ± 0,3

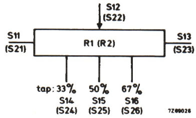
solder tags


4,2 min
1,1 +0 −0,1
7Z66894.1
0,2
3,81 ± 0,30

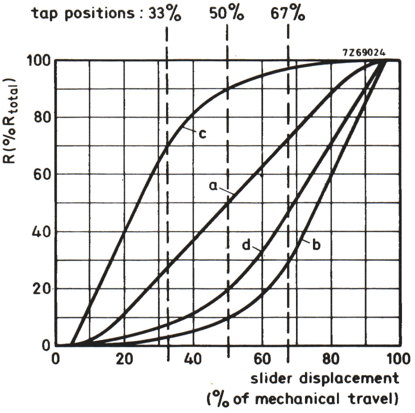
holes:
(viewed on
component side)

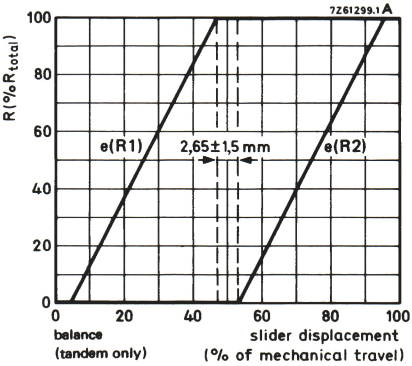

S11
S12
S14
S15
S16
S101
(S10)
S13
3e
(S21)
S201
(S24)
(S25)
(S26)
(S22)
(S23)
6e
10e
12e
16e
e = 2,54
7Z690691

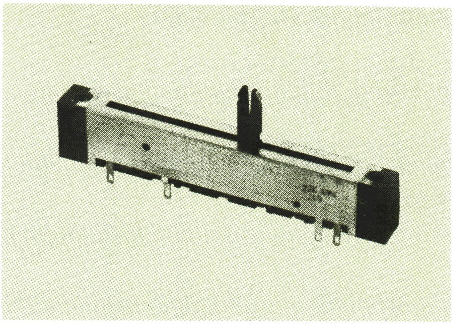
marking is always placed at
the beginning of R1 (S11)


S12 (S22)
S11 (S21)
R1 (R2)
S13 (S23)
tap: 33% 50% 67%
S14 (S24)
S15 (S25)
S16 (S26)
7Z69026

earthing screen
S101; S201 external
S10 internal







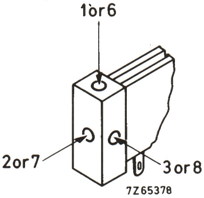
Composition of the catalogue no.

2322 43

code for screw-mounting facility

single
0 = without
1 = making use of holes in top and bottom
2 = making use in holes in the small sides
3 = making use of holes in front and back

tandem
5 = without
6 = making use of holes in top and bottom
7 = making use of holes in the small sides
8 = making use of holes in front and back



code for resistance law and nominal resistance, see table below

code for tap
0 = without tap
1 = tap at 1/3
2 = tap at 1/2
4 = taps at 1/3 and 2/3

code for terminals and screening
0 = without screening
1 = with internal screening*
2 = with internal and external screening*
3 = with external screening
} with solder tags

5 = without screening
6 = with internal screening*
7 = with internal and external screening*
8 = with external screening
} with printed-wiring pins

code for adjustment provision
0 = asymmetrically placed
1 = symmetrically placed
} length 12,5 mm

2 = asymmetrically placed
3 = symmetrically placed
} length 16 mm

* Only for tandem potentiometers.

code in catalogue no.

nominal resistance	linear law curve a	log. law curve b	rev. log. law curve c	semi-log. law curve d	balance without tap only curve e
220 Ω	02				
330 Ω	19				
470 Ω	03				
1 kΩ	04	24	44	64	
2,2 kΩ	05	25	45	65	
4,7 kΩ	06	26	46	66	
10 kΩ	07	27	47	67	87
22 kΩ	08	28	48	68	88
47 kΩ	09	29	49	69	89
100 kΩ	11	31	51	71	91
220 kΩ	12	32	52	72	92
470 kΩ	13	33	53	73	93
1 MΩ	14	34	54	74	94
2,2 MΩ	15	35	55	75	95
4,7 MΩ	16	36	56	76	

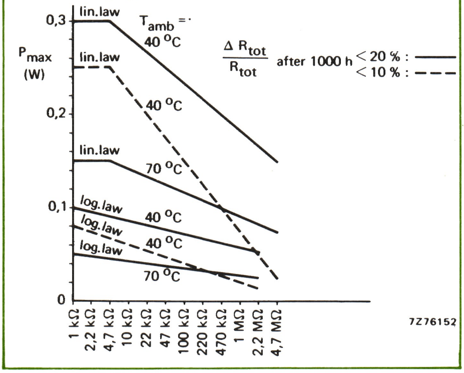
variable resistors

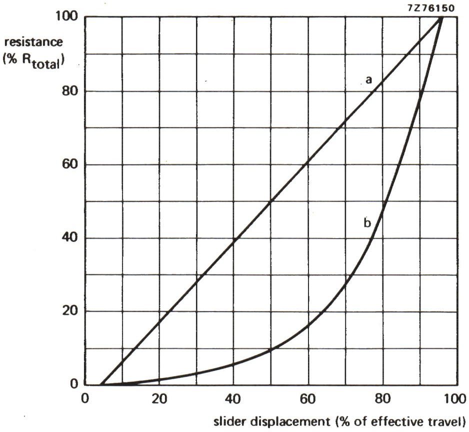
control potentiometers

SLP25 — slide carbon
25 mm — linear and logarithmic laws

Status D

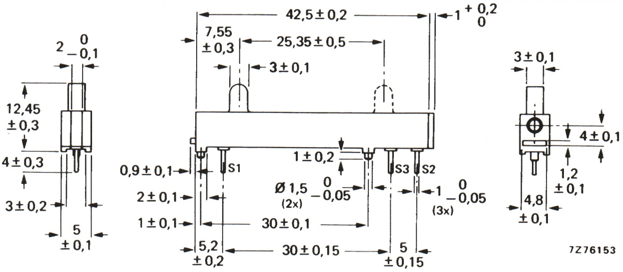
Nominal resistance	
linear law	**1 kΩ – 4,7 MΩ**
logarithmic law	**1 kΩ – 2,2 MΩ**
Climatic category, IEC 68	**25/070/21**





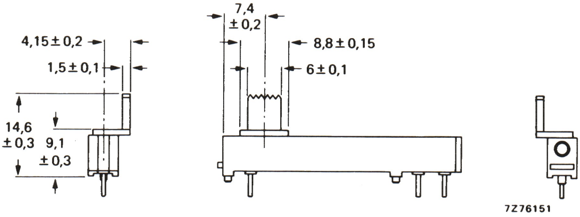
Potentiometer with symmetrically placed slider.

S_1 and S_3 = beginning and end terminals
S_2 = slider terminal



2 0 −0,1
12,45 ±0,3
4±0,3
3±0,2
5 ±0,1
42,5±0,2
1 +0,2 0
7,55 ±0,3
25,35±0,5
3±0,1
1±0,2
0,9±0,1
S1
S3
S2
Ø1,5 0 −0,05 (2x)
2±0,1
1 0 −0,05 (3x)
1±0,1
30±0,1
5,2 ±0,2
30±0,15
5 ±0,15
3±0,1
4±0,1
1,2 ±0,1
4,8 ±0,1
7Z76153

Potentiometer with asymmetrically placed slider.



4,15±0,2
1,5±0,1
14,6 ±0,3
9,1 ±0,3
7,4 ±0,2
8,8±0,15
6±0,1
7Z76151

Composition of the catalogue no.

2322 415 . 00 . .

code for slider
1 = symmetrically placed
2 = asymmetrically placed

code in catalogue no.

nominal resistance	linear law curve a	logarithmic law curve b
1 kΩ	04	24
2,2 kΩ	05	25
4,7 kΩ	06	26
10 kΩ	07	27
22 kΩ	08	28
47 kΩ	09	29
100 kΩ	11	31
220 kΩ	12	32
470 kΩ	13	33
1 MΩ	14	34
2,2 MΩ	15	35
4,7 MΩ	16	

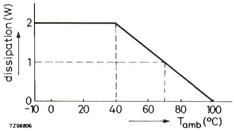
variable resistors

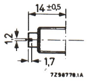
control potentiometers

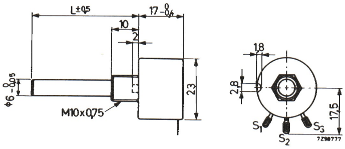
WCP23 — wirewound
linear law — 2 W

Status D

Max dissipation

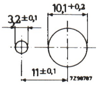






supplied with nut
catalogue no. of spare nuts
4322 047 00350

mounting holes



resistance value Ω	temperature coefficient ppm/ °C	code in catalogue no.
2,2	0 to +600	228
3,3		338
4,7		478
6,8		688
10		109
15		159
22	– 25 to +25	229
33		339
47		479
68		689
100		101
150		151
220	0 to +140	221
330		331
470		471
680		681
1000		102
1500		152
2200		222
3300		332
4700		472
6800		682
10000	– 20 to +140	103
15000		153
22000		223

Composition of the catalogue no.

2322 01 . . . . . .

figure indicating the spindle material
2 = plastic
3 = steel

resistance code

figure indicating the spindle type

figure indicating the tolerance
1 = ± 10%
2 = ± 5% ($R_n > 47\ \Omega$)

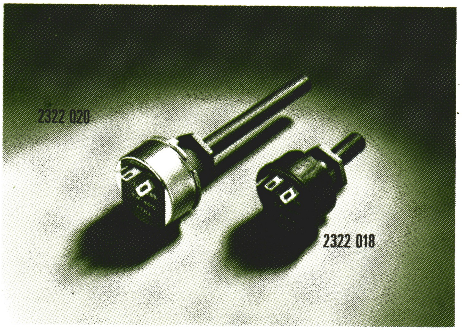
0 = length 14 mm slotted plastic spindle

plain spindle:
2 = length 17 mm
3 = length 25 mm
4 = length 50 mm
5 = length 60 mm
6 = length 20 mm
7 = length 30 mm

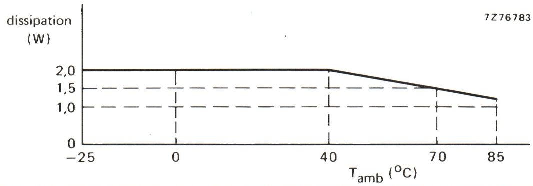
Example: For a potentiometer with a nominal resistance value of 10 Ω, tolerance ± 10%, with slotted plastic spindle, the catalogue no. is 2322 012 01109.

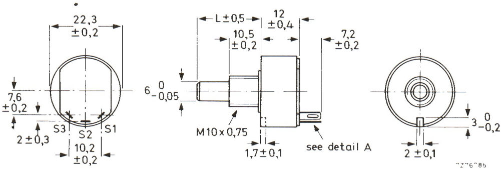
WCP22 — wirewound linear law — 2 W

Status D


2322 020
2322 018

Max dissipation




22,3
±0,2
7,6
±0,2
2 ±0,3
S3
S2
S1
10,2
±0,2
L ±0,5
12
±0,4
10,5
±0,2
7,2
±0,2
6 0 −0,05
M10 x 0,75
1,7 ±0,1
see detail A
3 0 −0,2
2 ±0,1
7Z76785

Ω	ppm/°C	
2,2	−25 to +600	228
3,3		338
4,7		478
6,8		688
10		109
15		159
22		229
33		339
47		479
68	−25 to +25	689
100		101
150		151
220	0 to +140	221
330		331
470		471
680		681
1000		102
1500		152
2200		222
3300		332
4700		472
6800		682
10000		103

Composition of the catalogue no.

2322 0 . . . .

resistance code

18 = plastic case and spindle
20 = steel case and spindle

figure indicating the spindle type

0 = slotted spindle; length 16 mm
2 = slotted spindle; length 17 mm
3 = slotted spindle; length 20 mm
4 = slotted spindle; length 30 mm
5 = plain spindle; length 60 mm

figure indicating the tolerance

1 = ± 10% (2322 018 only)
2 = ± 5% (2322 020 only)

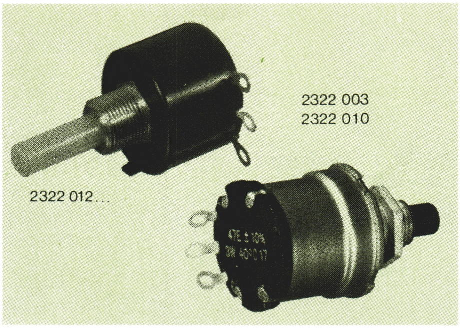
Example: For a potentiometer with a nominal resistance value of 10 Ω, tolerance ± 10%, with slotted plastic spindle, the catalogue no. is 2322 018 01109.

variable resistors

control potentiometers

WCP24 — wirewound
linear law — 3 W

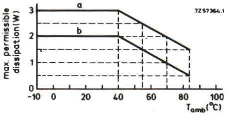
Status D

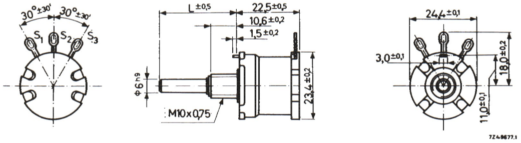

2322 003
2322 010
2322 012...
47E ± 10%
3W 4050 17

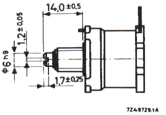
Max dissipation

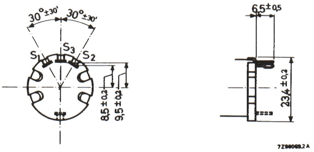
Curve a: mounted on a metal chassis 100 x 100 x 1 mm

Curve b: mounted on an insulating panel

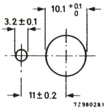



30°±30'
30°±30'
S1
S2
S3
L ±0,5
22,5±0,5
10,6±0,2
1,5±0,2
Φ6 h9
M10x0,75
23,4±0,2
24,4±0,1
3,0±0,1
18,0±0,2
11,0±0,1
7Z49677.1


14,0±0,5
1,2±0,05
Φ6 h9
1,7±0,25
7Z49729.1A


30°±30'
30°±30'
S1
S3
S2
8,5±0,2
9,5±0,2
6,5±0,5
23,4±0,2
7Z00068.2A

mounting holes


10.1 +0.1 0
3.2±0.1
11±0.2
7Z98028.1

resistance value Ω	temperature coefficient ppm/°C	code in catalogue no.
2,2	0 to +600	228
3,3		338
4,7		478
6,8		688
10		109
15		159
22		229
33	− 25 to +600	339
47		479
68	− 25 to +25	689
100		101
150		151
220		221
330	− 25 to +140	331
470		471
680	0 to +140	681
1000		102
1500		152
2200		222
3300		332
4700		472
6800		682
10000	− 20 to +140	103
15000		153
22000		223

Composition of the catalogue no.

2322 0 . . . .

figure indicating the type
03 = potentiometer with solder tags at the side
10 = potentiometer with solder tags at the bottom

resistance code

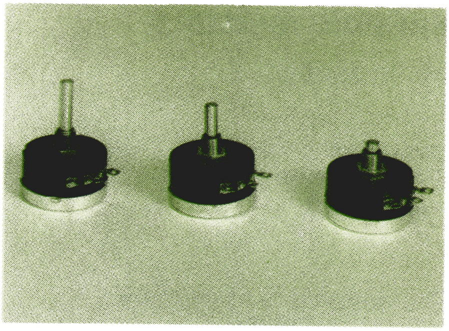
figure indicating the spindle type
0 = slotted spindle
2 = plain spindle; length 17 mm
3 = plain spindle; length 20 mm
4 = plain spindle; length 30 mm
5 = plain spindle; length 60 mm

figure indicating the tolerance and tap
1 = ± 10%
2 = ± 5% ($R_n > 47\ \Omega$)
6 = ± 10% with tap
7 = ± 5% ($R_n > 47\ \Omega$) with tap

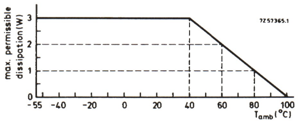
6 and 7 with tap at 50% of effective angle of rotation

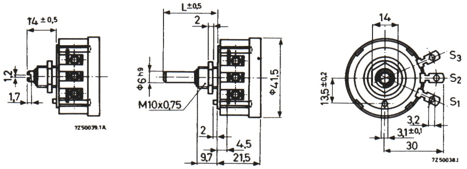
WCP41 – wirewound linear law – 3 W

Status D



Max dissipation

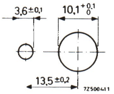




14 ±0,5
1,2
1,7
7Z50039.1A
L±0,5
2
Φ6 h9
M10x0,75
2
4,5
9,7
21,5
Φ41,5
14
13,5±0,2
S3
S2
S1
3,2
3,1±0,1
30
7Z50038.1

supplied with nut
catalogue no. of spare nuts
4322 047 00350

mounting holes



3,6±0,1
10,1 +0,1 0
13,5±0,2
7Z50041.1

resistance value Ω	temperature coefficient ppm/ °C	code in catalogue no.
10	0 to +600	109
15		159
20		209
25		259
35		359
50		509
75		759
100	– 25 to +25	101
150		151
200		201
250		251
350		351
500		501
750		751
1000		102
1500	0 to +140	152
2000		202
2500		252
3500		352
5000		502
7500		752
10000		103
15000		153
20000		203
25000		253
35000	– 20 to +20	353
50000		503

Composition of the catalogue no.

2322 004 . . . . .

figure indicating the spindle type
2 = slotted spindle
3 = plain spindle; length 20 mm
4 = plain spindle; length 25 mm
5 = plain spindle; length 30 mm
6 = plain spindle; length 35 mm
7 = plain spindle; length 80 mm

resistance code

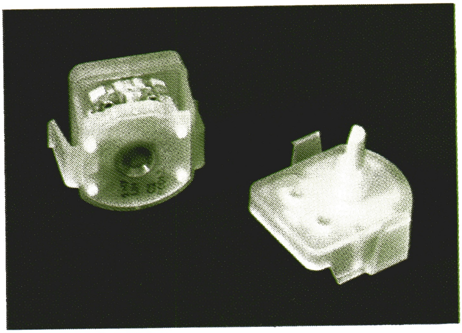
figure indicating the tolerance
1 = ± 10%
2 = ± 5% ($R_n > 75\ \Omega$)

variable resistors

focus control

2322 460 900 . . — carbon
23 mm — linear law

Status D

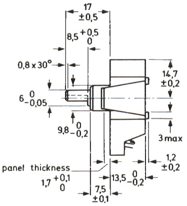


These special versions for tv focus trimming have a snap-in construction.

2322 460 90009/11/12

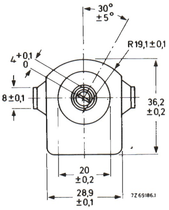
Max dissipation at T_{amb} = 40 °C	
linear	1 W
Operating temperature	−10 to +70 °C
Climatic category IEC 68	10/070/21

side view



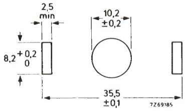
17 ±0,5
8,5 +0,5 0
0,8 x 30°
6 0 −0,05
9,8 0 −0,2
14,7 ±0,2
3 max
1,2 ±0,2
panel thickness
1,7 +0,1 0
13,5 0 −0,2
7,5 ±0,1

front view



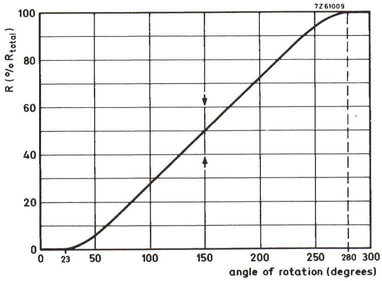
30° ±5°
R 19,1 ± 0,1
4 +0,1 0
8 ± 0,1
36,2 ±0,2
20 ±0,2
28,9 ±0,1
7Z69186.1

mounting holes



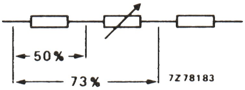
2,5 min
10,2 ±0,2
8,2 +0,2 0
35,5 ±0,1
7Z69185

nominal resistance	catalogue no.
470 kΩ	2322 460 90009
10 MΩ	2322 460 90011
2,7 MΩ	2322 460 90012

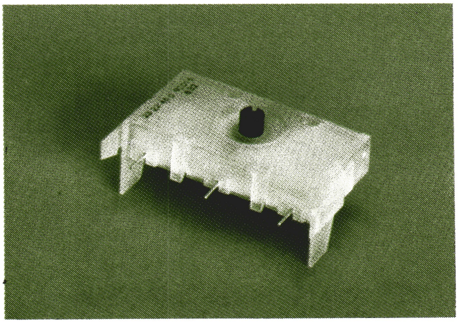


Focus unit 2322 460 90016

Resistance value	23 MΩ
Tolerance	± 15%
Max dissipation at T_{amb} = 70 °C	3,8 W
Max d.c. voltage	8,5 kV



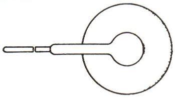
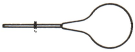
50 %
73 %
7Z78183



non-linear resistors

VDR — survey

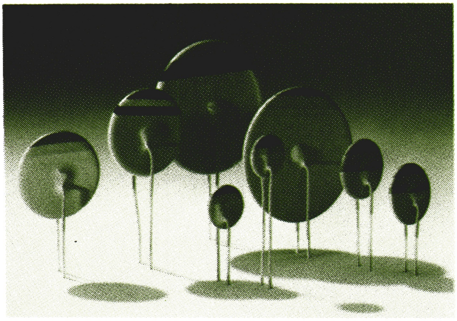
For detailed information
Handbook CM2a

type	voltage V	current mA	dissipation W	β-value	catalogue no.	status	page
DISC 	8 to 330	100 to 1	0,8	0,14 to 0,40	2322 552 0	D	C42
	8 to 330	100 to 1	1	0,14 to 0,40	2322 553 0		
	8 to 330	100 to 1	2	0,14 to 0,40	2322 554 0		
	8 to 330	100 to 1	3	0,14 to 0,40	2322 555 0		
SMALL DISC 	2,7 to 68	1	0,25	0,11 to 0,28	2322 581 03 . . .	D	C44
	48	0,05	0,1	0,035	2322 592 90001 2322 592 90003	D	C43
	50 to 425			0,03	2322 594 1	D	C44
ROD 	56 to 1300	1 to 10	0,8	0,16 to 0,36	2322 564 02 . . . 2322 564 03 . . . 2322 564 90 . . .	D	C43

non-linear resistors

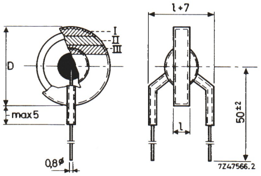
VDR

2322 552 2322 553 2322 554 2322 555 – discs



Very suitable for voltage stabilization, contact protection and spark suppression. These types consist of a disc provided with two tinned solid copper wires.

Series no.	552	553	554	555	
Max dissipation	0,8	1	2	3	W
Diameter D	14,5	20	27,5	42,5	mm
Operating temperature					
at zero power	–25 to 125 °C				
at max power	0 to 55 °C				
β between 0,3 and 3 x I_{nom}	0,14 to 0,40				



Composition of the catalogue no.

2322 . . . 0 . . . .

series no.

tolerance on V:

1 20%, untipped

2 10%, silver tipped

I_{nom} mA	V at I_{nom} V	code in catalogue no. 552	553	554	555	l mm
100	8	116	116	116	116	3
	10	118	118	118	118	3
	12	120	120	120	120	3
	15		122	122	122	3
	18			124	124	3
	22				126	3
	27				128	3
	33				130	3
10	8	216				3
	10	218	218			3
	12	220	220	220		3
	15	222	222	222		3
	18	224	224	224		3
	22	226	226	226	226	3
	27	228	228	228	228	3
	33	230	230	230	230	3
	39	232	232	232	232	3
	47	234	234	234	234	5
	56	236	236	236	236	5
	68	238	238	238	238	5
	82		240	240	240	5
	100			242	242	5
	120			244	244	5
	150			246	246	5
	180			248	248	5
	220				250	5
	270				252	5
1	56	336				5
	68	338	338			5
	82	340	340			5
	100	342	342			5
	120	344	344			5
	150	346	346	346		5
	180	348	348	348		5
	220	350	350	350	350	5
	270	352	352	352	352	5
	330	354	354	354	354	5

Marking

Each resistor is marked with three coloured bands, indicating the code e.g. 116:

I = brown

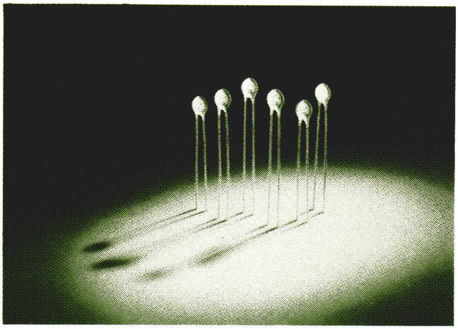
II = brown

III = blue

colour code

black	0
brown	1
red	2
orange	3
yellow	4
green	5
blue	6
violet	7
grey	8
white	9

2322 564 – rod
2322 592 – small disc

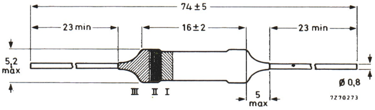


To be used for stabilization of voltages, protection of contacts, etc.
These rods are provided with two axial tinned solid copper wires. They are tan lacquered, but not insulated.

2322 564

P_{max} = 0,8 W

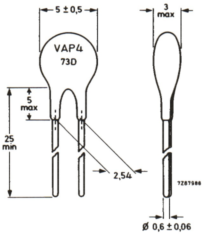
I_{nom} mA	V at I_{nom} V(d.c.)	tolerance on V in %		β-value	colour code; I, II, III	catalogue no. 2322 564 .....
10	470	10		0,20–0,25	green	02582
10	560	10		0,18–0,23	blue	02602
10	680	10		0,18–0,23	violet	02622
10	910	10		0,17–0,22	white	90014
10	1200	20		0,17–0,22	grey	02681
10	1200	10		0,17–0,22	brown	02682
10	1300	10		0,16–0,21	red	90015
2	950	10		0,16–0,21	black, blue	90005
1	56	20	see note	0,29–0,36	orange, orange, blue	03361
1	68	20		0,29–0,36	orange, orange, grey	03381
1	82	20		0,29–0,36	orange, yellow, black	03401
1	100	20		0,25–0,32	orange, yellow, red	03421
1	120	20		0,25–0,32	orange, yellow, yellow	03441
1	150	20		0,22–0,29	orange, yellow, blue	03461
1	180	20		0,22–0,29	orange, yellow, grey	03481
1	220	20		0,21–0,28	orange, green, black	03501
1	270	20		0,21–0,28	orange, green, red	03521
1	300	20		0,18–0,25	yellow	90016



Note: change 1 into 2 for 10% tolerance

2322 592

Nom d.c. voltage	48	V
Nom dissipation	0,1	W
Operating temperature	– 55 to +85	°C
Climatic category NF C 20-600, par. 4.3	454(55/085/56)	
β-value between 0,1 and 1 mA	typ 0,035	



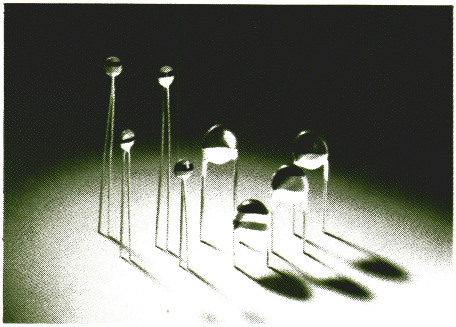
Catalogue no.
2322 592 90001 – is marked, see drawing.
90003 – is not marked.

These VDRs are for relay contact protection in telephone exchanges, etc. and are homologated in France under NF C 93-277/UTE 93-277 and in Belgium under certificate number 73-209.

non-linear resistors

VDR

2322 581 — small disc
2322 594 — small disc



2322 581: when you need a low β at a low voltage this titanium oxide disc is excellent for your application.

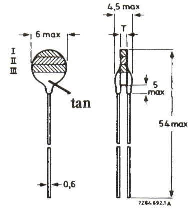
2322 594: zinc oxide disc VDR, especially designed for voltage transient or spark suppression, contact protection, protection against secondary lightning effects, etc.

2322 581

Operating temperature		
at zero power	−25 to +125	°C
at max power	0 to + 55	°C
Max dissipation	0,25	W
Tolerance on voltage at 1 mA	± 10, ± 20	%

Marking
Each resistor is marked with
three coloured bands

Example: . 308 .
I = orange = 3
II = black = 0
III = grey = 8



d.c. voltage at 1 mA V	max β-value between 1-10 mA	capacitance nF	catalogue no. 2322 581 . . . . .
2,7	0,28	40	0304 .
3,3	0,28	35	0306 .
3,9	0,28	29	0308 .
4,7	0,25	24	0310 .
5,6	0,25	21	0312 .
6,8	0,22	18	0314 .
8,2	0,22	16	0316 .
10	0,22	14	0318 .
12	0,22	12	0320 .
15	0,22	11	0322 .
18	0,22	9,5	0324 .
22	0,20	8	0326 .
27	0,20	7	0328 .
33	0,20	5,5	0330 .
39	0,20	5	0332 .
47	0,20	4	0334 .
56	0,20	3	0336 .
68	0,20	2	0338 .

tolerance 1 = 20%
2 = 10%

shown as I, II, III

2322 594

Operating temperature		
at zero power	−55 to +115	°C
at max power	−55 to + 85	°C
Voltage ratio V_2/V_1 for $I_2/I_1 = 10$	typ 1,07	
Max non-repetitive transient energy	6	J
β between 1 mA and 1 A	typ 0,03	

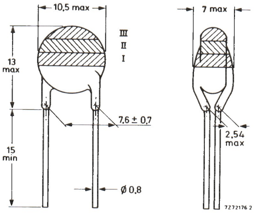
working voltage (r.m.s.) V	V_{min} at I_{peak} = 1 mA * V	V_{max} at I_{peak} = 1 A ▲ V	crest working voltage (max) V	catalogue no. 2322 594 . . . . .
50	82	140	75	18202
60	100	170	95	11012
95	150	255	150	11512
120	190	325	185	11912
135	220	375	210	12212
165	270	460	255	12712
205	330	560	320	13312
220	350	595	340	13512
245	390	665	380	13912
295	470	800	455	14712
390	620	1055	605	16212
425	680	1160	660	16812

shown as I, II, III

* Pulse 10 ms.
▲ Rectangular pulse; voltage measured after 1 ms.

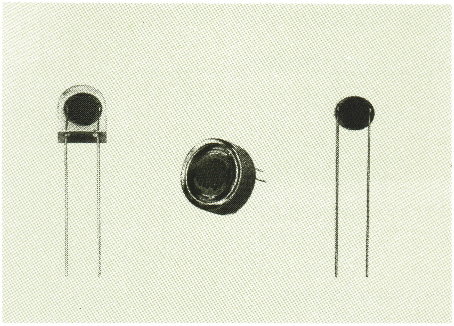
colour code

black	0
brown	1
red	2
orange	3
yellow	4
green	5
blue	6
violet	7
grey	8
white	9



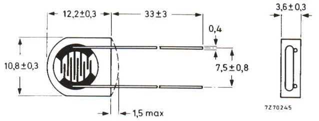
LDR

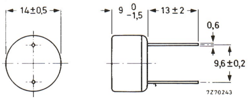
2322 600

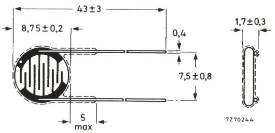


The light dependent resistors are intended for non-critical on-off applications, in which a lamp or a relay is operated either directly (low power) or via a suitable amplifier (high power) e.g. in toys.

P max mW	V_{peak} max V	R_D min MΩ	R_L at 1000 lux 2850 K Ω	catalogue no. 2322 600	status
plastic encapsulated					
100	150	10	75–300	93001	D
100	150	1	< 110	93002	
200	110	10	75–300	95001	D
200	110	10	< 250	95003	
200	110	1	< 110	95006	
200	110	10	< 190	95007	
lacquered					
100	150	10	75–300	94001	D


12,2±0,3
33±3
3,6±0,3
0,4
10,8±0,3
7,5±0,8
1,5 max
7Z70245

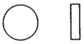
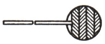
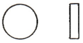
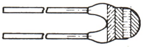
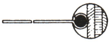
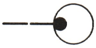
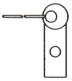
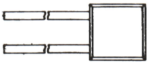
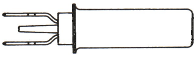
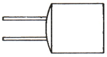
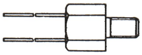
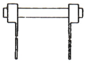

14±0,5
9 0 −1,5
13±2
0,6
9,6±0,2
7Z70243

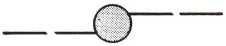
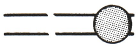
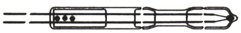
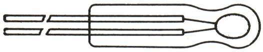
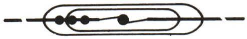
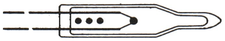
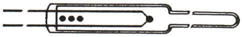
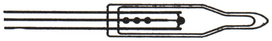

43±3
8,75±0,2
1,7±0,3
0,4
7,5±0,8
5 max
7Z70244

non-linear resistors

NTC thermistors — survey

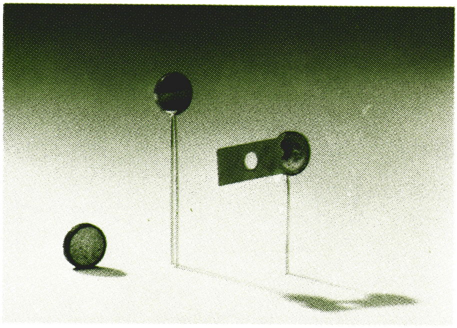
For detailed information
Handbook CM2a

type	catalogue no.	status	page
DISC 	2322 610 0	D	C47
	2322 610 1 . . . . 2322 642 1	D D	C47 C50
	2322 611	D	C48
	2322 640 90012 2322 640 90014	D	C49
	2322 643 1 . . . . 2322 644 1	D	C51
	2322 644 90004 2322 644 90005	D	C51
on metal strip 	2322 610 900 . .	D	C47
moulded 	2322 640 90004 2322 640 90005 2322 640 90013 2322 640 90015	D	C52
in special housing 	2322 640 90007	D	C49
	2322 640 90008	D	C49
	2322 642 2	D	C53
ROD 	2322 635 . . . . . 2322 636 . . . . . 2322 637	D	C54

type	catalogue no.	status	page
MINIATURE BEAD			
	2322 634 0	D	C56
	2322 634 1	D	C56
glass encapsulated 	2322 627 1 . . . . 2322 627 4 . . . . 2322 627 5	D	C55
	2322 627 2 . . . . 2322 627 31 . . .	D D	C55 C57
	2322 634 2	D	C56
	2322 634 3	D	C56
	2322 634 4	D	C56
INDIRECTLY HEATED			
	2322 628 01332 2322 628 01334	D	C57

NTC thermistors

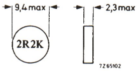
2322 610 — disc



General purpose thermistors.
2322 610 900 . . on metal strip is specially designed for temperature compensation in deflection units.

Resistance range at 25 °C	1,1 to 1300 Ω
Dissipation	max 1 W
Operating temperature	
at zero power	– 25 to +125 °C
at max power	0 to +55 °C

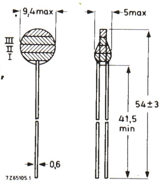
WITHOUT leads


9,4max
2,3max
2R2K
7Z65102

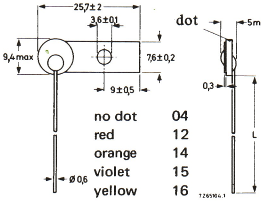
WITH leads

Coloured bands give last three digits of catalogue no. I and II follow standard colour code. III is standard except: gold = 8, black = 9.

Example
228 = red, red, gold


9,4max
III
II
I
5max
54±3
41,5 min
0,6
7Z65105.1

WITH leads, on metal strip


25,7±2
3,6±0,1
dot
5max
9,4max
7,6±0,2
9±0,5
0,3
L
ø 0,6
7Z65104.1

no dot	04
red	12
orange	14
violet	15
yellow	16
green	17
blue	18

Catalogue no. 2322 610 0 . . . .

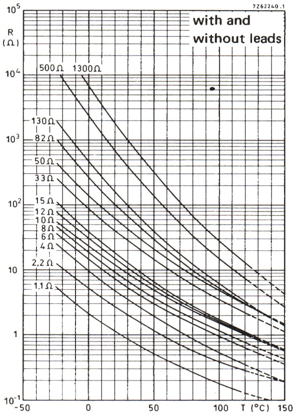
marking	tolerance	
K	10%	2
M	20%	1

Catalogue no. 2322 610 1 . . . .

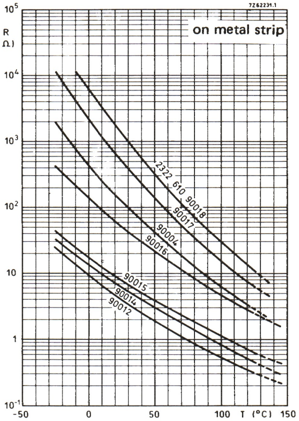
tolerance:	
10% (silver tipped)	2
20% (untipped)	1

Catalogue no. 2322 610 900 . .

tolerance 20% only



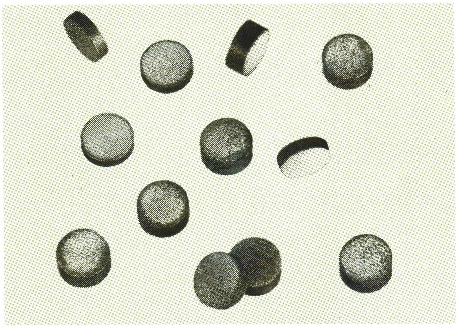
R25 Ω	B25/85 ± 5% K		
1,1	2600	118	–
2,2	2675	228	–
4	2800	408	12
6	2825	608	14
8	2900	808	15
10	2950	109	–
12	3050	129	–
15	3125	159	–
33	3250	339	–
50	3300	509	16
82	4400	829	–
130	4600	131	04
500	5200	501	17
1300	5450	132	18



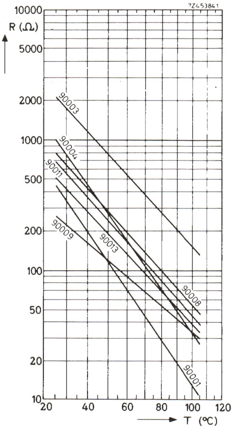
non-linear resistors

NTC thermistors

2322 611 — disc

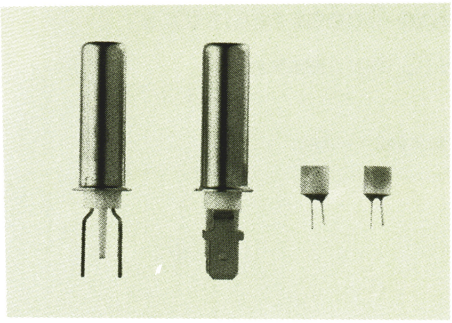


resistance in Ω at					diameter	catalogue no.
25 °C	40 °C	50 °C	96,5 °C	100 °C	mm	2322 611 900 . .
270		97 –143		29,5–36,5	6,9 ± 0,2	09
500		92,5–134		12 –15	6,9 ± 0,2	01
500		175 –215		35 –43	6,9 ± 0,2	13
700		207 –264		41,4–48,6	6,9 ± 0,2	11
800		244 –315		48,0–58,6	6,9 ± 0,2	08
1000		221,5–318,5		30 –36	6,9 ± 0,2	04
2200	1030–1310		147–173		7,0 ± 0,3	03

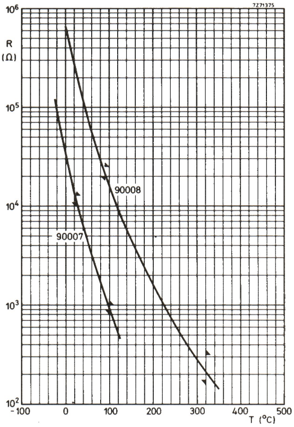


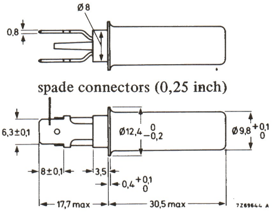
This range of discs has been developed for temperature sensors for the cooling water in motor cars. The NTCs are specified at a medium temperature (40 to 50 °C) and a higher temperature (96,5 to 100 °C), so that a high accuracy at the working temperature is obtained.
They are also suitable for temperature control in household appliances, such as washing machines.

2322 640 90007 90008
90012 90014

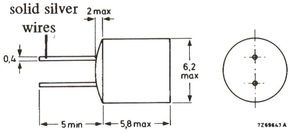


Catalogue no. 2322 640		90007	90008	
Resistance at:	+25 °C	12 ± 7%	215 approx.	kΩ
	+90 °C	—	22 ± 10%	kΩ
	+100 °C	950 ± 5%	—	Ω
	+320 °C	—	235 ± 75	Ω
$B_{25/85}$		3750	—	K
$B_{50/150}$		—	4000 ± 5%	K
Operating temperature				
at zero power		−25 to +125	0 to 250	°C
at max power		—	0 to 350	°C
Application area		washing machines	hotplates	



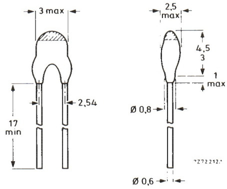

Ø8
0,8
spade connectors (0,25 inch)
6,3±0,1
Ø12,4 $^{0}_{-0,2}$
Ø9,8 $^{+0,1}_{0}$
8±0,1
3,5
0,4 $^{+0,1}_{0}$
17,7 max
30,5 max
7Z69644 A

2322 640 90007
in a stainless steel package


solid silver wires
2 max
0,4
6,2 max
5 min
5,8 max
7Z69643 A

2322 640 90008 in a ceramic package

Catalogue no. 2322 640	90012	90014	
Resistance at:			
−31,5 to −28,5 °C	50	—	kΩ
−21,5 to −18,5 °C	27	—	kΩ
−11,5 to −8,5 °C	15	15	kΩ
+ 23,5 to + 26,5 °C	—	2,7	kΩ
$B_{25/85}$	4000	4000	K
Maximum dissipation	0,25	0,25	W
Operating temperature			
at zero power	−55 to +85	−55 to +85	°C
at maximum power	−55 to +55	−55 to +55	°C
Application area	general	general	

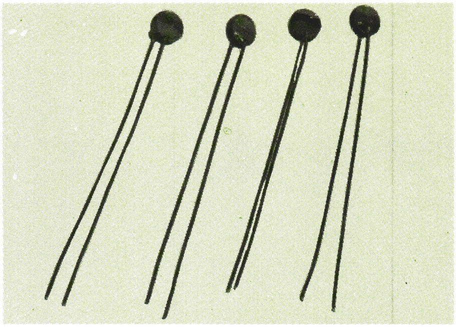

3 max
2,5 max
4,5
3
1 max
2,54
17 min
Ø 0,8
Ø 0,6
7Z72212.1

2322 640 90012 grey body — brown cap
2322 640 90014 grey body — red cap

non-linear resistors

NTC thermistors

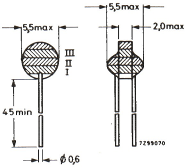
2322 642 1 — disc



Resistance range (E6 series) at 25 °C		3,3 Ω to 330 kΩ
Dissipation at 55 °C	max	0,5 W
Thermal time constant, free air	approx.	25 s
Operating temperature at zero power		−25 to +125 °C

Coloured bands give last three digits of catalogue no. I and II follow standard colour code. III is standard except: gold = 8, black = 9.

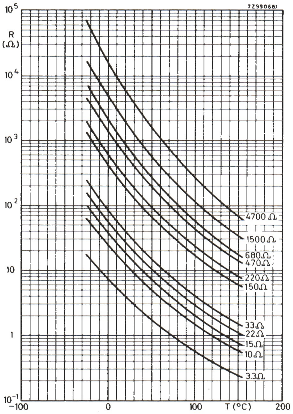
Example
338 = orange, orange, gold

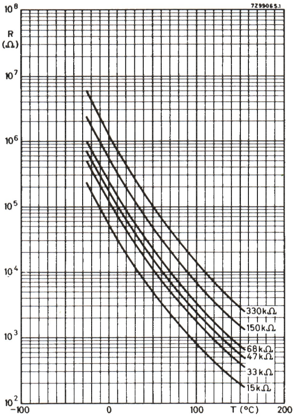


R25	B25/85 ± 5% K	catalogue no.
3,3 Ω	2600	2322 642 1 . 338
4,7	2665	1 . 478
6,8	2730	1 . 688
10	2800	1 . 109
15	2870	1 . 159
22	2935	1 . 229
33	3010	1 . 339
47	3070	1 . 479
68	3135	1 . 689
100	3200	1 . 101
150	3280	1 . 151
220	3350	1 . 221
330	3440	1 . 331
470	3520	1 . 471
680	3600	1 . 681
1 kΩ	3680	1 . 102
1,5	3775	1 . 152
2,2	3915	1 . 222
3,3	4070	1 . 332
4,7	4200	1 . 472
6,8	4300	1 . 682
10	4400	1 . 103
15	4375	1 . 153
22	4200	1 . 223
33	4250	1 . 333
47	4325	1 . 473
68	4375	1 . 683
100	4400	1 . 104
150	4600	1 . 154
220	4650	1 . 224
330	4700	1 . 334

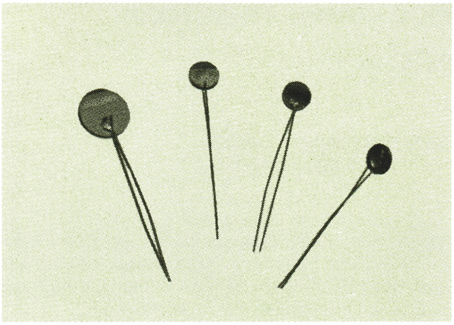
tolerance on R25:

20% (untipped)	1
10% (silver tipped)	2
5% (gold tipped)	3





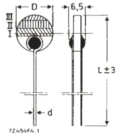
2322 643 1
2322 644 1 — disc
2322 644 9



2322 643 1 and 2322 644 1

Resistance range at 25 °C	150 to 4700 Ω	
Operating temperature at zero power	− 25 to +125 °C	
2322 . . .	643	644
Dissipation at 25 °C max	1	1,5 W
Thermal time constant	55	120 s

Coloured bands give last three digits of catalogue no. I and II follow standard colour code. III is standard except: gold = 8, black = 9



Example

152 = brown, green, red

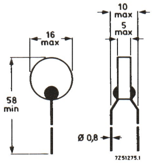
P_{max} W	R_{25} Ω	$B_{25/85}$ ± 5% K	catalogue no.
1	**150**	3500	2322 643 1 . 151
	470	3750	471
	1500	4000	152
	4700	4200	472
1,5	**150**	3600	2322 644 1 . 151
	470	3900	471
	1500	4200	152
	4700	4300	472

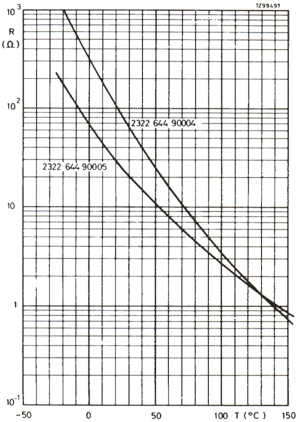
tolerance on R_{25}:	
20%	1
10% (silver band)	2

	D	L	d
2322 643	9 ± 0,5	54	0,6
2322 644	15 ± 0,7	58	0,8

2322 644 9 for surge limitation in tv

Catalogue no. 2322 644	90004	90005	
Resistance at 25 °C	82 (± 20%)	> 15	Ω
at T_{amb} = 25 °C; I_{rms} = 1,7 A	< 0,85	—	Ω
= 2,2 A	—	< 1	Ω
Dissipation factor	19	17	mW/ °C
$B_{25/85}$	4650	3350	K
Repetitive peak voltage (50—60 Hz) max	345	380	V
Thermal time constant	115	148	s
Operating temperature			
at zero power	− 25 to +155		°C
at max power	0 to + 55		°C

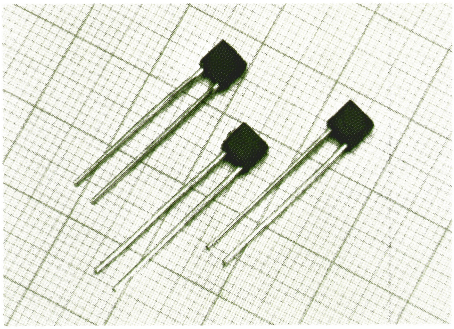




non-linear resistors

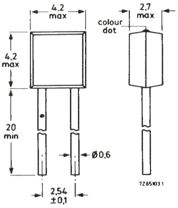
NTC thermistors

2322 640 90004 90005
90013 90015



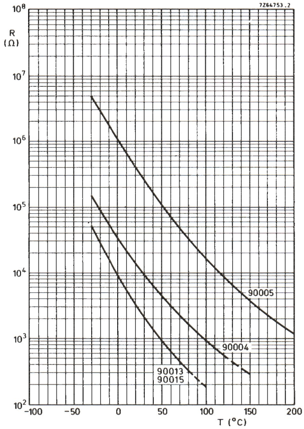
Temperature sensing elements for domestic and professional/industrial applications with rugged housing and great reliability. They can be built-in directly, are resistant to industrial atmospheres, and can also be cast-in.

Catalogue no. 2322 640		90004	90005	
Resistance at:	+25 °C	12 000 ± 7%	–	Ω
	+100 °C	950 ± 5%	16 700 ± 7%	Ω
	+200 °C	–	1120 ± 7%	Ω
Dissipation	max	0,25	0,25	W
$B_{25/85}$		3750	4300	K
Operating temperature				
at zero power		–10 to +125	–25 to +200	°C
at max power		0 to +55	0 to +55	°C
Application area		general purpose	high temperature control	

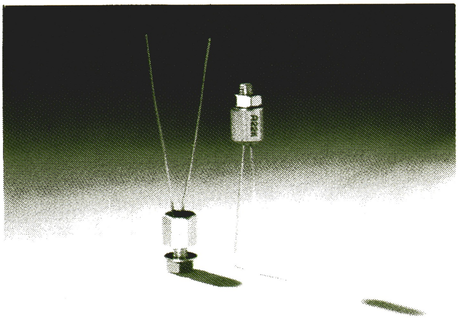


Catalogue no. 2322 640	90013	90015	
Resistance at:			
–31,5 to –28,5 °C	50	–	kΩ
–21,5 to –18,5 °C	27	–	kΩ
–11,5 to –8,5 °C	15	15	kΩ
+23,5 to +26,5 °C	–	2,7	kΩ
$B_{25/85}$	4000	4000	K
Maximum dissipation	0,25	0,25	W
Operating temperature			
at zero power	–55 to +85	–55 to +85	°C
at max power	–55 to +55	–55 to +55	°C
Application area	deep-freezers	room temp control	

2322 640 90004: black body – grey dot
2322 640 90005: red body
2322 640 90013: black body – brown dot
2322 640 90015: black body – red dot

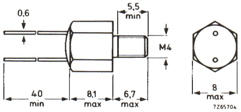


2322 642 2



Thanks to their high insulation resistance and good thermal contact these devices can be used in many control applications such as in sensing output stages, heater panels, etc.

Resistance range (E6) at 25 °C	3,3 Ω to 330 kΩ
Dissipation max	0,5 W
$B_{25/85}$	2600 to 4700 K
Thermal time constant	20 s
Dissipation factor	25 mW/ °C
Operating temperature range	
at zero power	− 25 to +100 °C
at max power	0 to + 55 °C

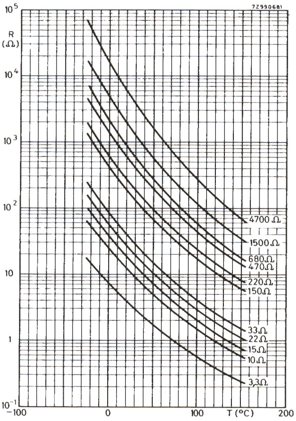


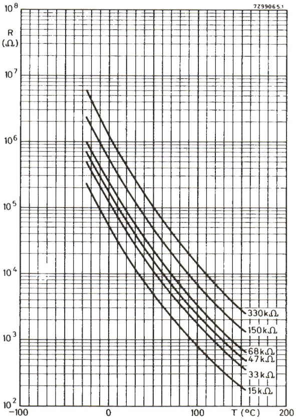
Catalogue no.
2322 642 2 . . . .

R_{25}	$B_{25/85}$ ± 5% K	
3,3 Ω	2600	338
4,7	2665	478
6,8	2730	688
10	2800	109
15	2870	159
22	2935	229
33	3010	339
47	3070	479
68	3135	689
100	3200	101
150	3280	151
220	3350	221
330	3440	331
470	3520	471
680	3600	681
1 kΩ	3680	102
1,5	3775	152
2,2	3915	222
3,3	4070	332
4,7	4200	472
6,8	4300	682
10	4400	103
15	4375	153
22	4200	223
33	4250	333
47	4325	473
68	4375	683
100	4400	104
150	4600	154
220	4650	224
330	4700	334

tolerance on R_{25}:

20%	1
10%	2
5%	3

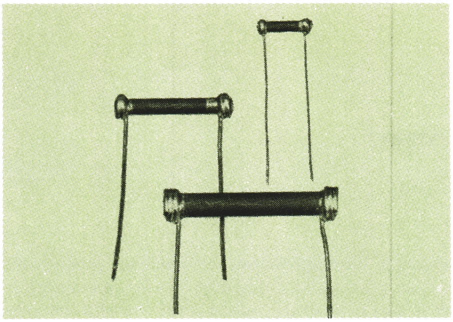




non-linear resistors

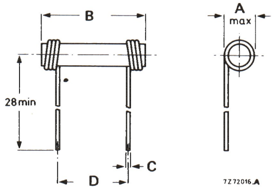
NTC thermistors

2322 635 to 637 — rods



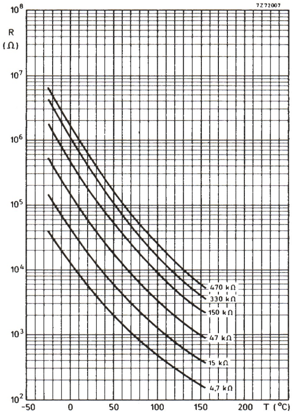
P_{max} at T_{amb} = 25 °C W	R_{25} ± 20% kΩ	$B_{25/85}$ ± 5% K	dissipation factor mW/°C	thermal time constant s	catalogue no.
0,6	**4,7**	3300	5	30	2322 635 01472
	15	3600			153
	47	3925			473
	150	4075			154
	330	4250			334
	470	4300			474
1,5	**4,7**	3250	10	55	2322 636 01472
	15	3550			153
	47	4000			473
	150	4150			154
2,3	**4,7**	3200	17	105	2322 637 01472
	15	3550			153
	47	3750			473
	150	4200			154

max operating temperature 155 °C.



series	A(max)	B ± 1	C	D ± 0,8
635	3,7	11	0,4	7,6
636	5,2	21	0,8	15,2
637	6,7	31	0,8	25,4

colour code	kΩ
orange	4,7
green	15
blue	47
white	150
yellow/blue	330
yellow/orange	470

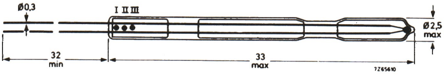


2322 627 1 2322 627 4
2322 627 2 2322 627 5

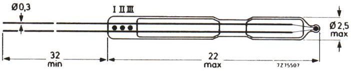
Miniature thermistors are used for temperature sensing, temperature compensation, air-flow measurements, vacuum measurements, delaying relays, and in medical science for temperature and breathing measurements.

Catalogue no.	2322 627 1	2322 627 2	2322 627 4	2322 627 5	
Resistance range (E6-series) at 25 °C	0,68 to 680	0,68 to 680	0,68 to 680	0,68 to 680	kΩ
$B_{25/85}$	2200 to 4100	2200 to 4100	2200 to 4100	2200 to 4100	K
Max dissipation	100	100	100	100	mW
Dissipation factor	0,7	0,7	0,6	approx. 1	mW/ °C
Thermal time constant	14	10	9,5	approx. 24	s
Operating temperature					
at zero power	–25 to +200	–25 to +200	–25 to +200	–25 to +200	°C
at max power	0 to +55	0 to +55	–25 to +55	–25 to +55	°C

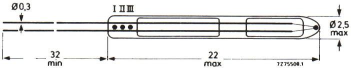
2322 627 1 . . . .


Ø0,3
I II III
Ø2,5 max
32 min
33 max
7Z65610

2322 627 4 . . . .

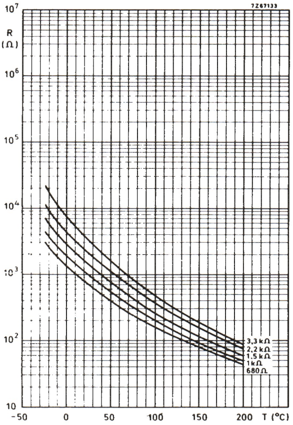

Ø0,3
I II III
Ø2,5 max
32 min
22 max
7Z75507

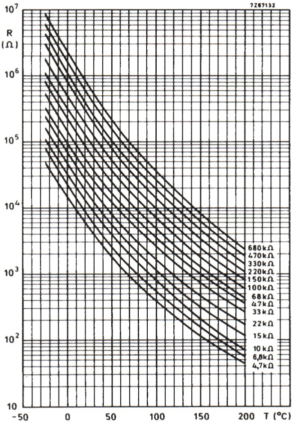
2322 627 5 . . . .


Ø0,3
I II III
Ø2,5 max
32 min
22 max
7Z75508.1

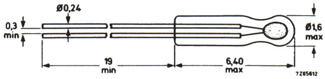
coloured dots I, II, III
stand for code in table

example: 681 I blue
II grey
III brown
tolerance 10% = silver dotted





2322 627 2 . . . .


Ø0,24
0,3 min
Ø1,6 max
19 min
6,40 max
7Z65612

This device is not code-marked. The catalogue no. is marked on each box of 100 pieces.

Catalogue no.

2322 627 . . . . .

style
tolerance on R_{25}:
1 = 20%, 2 = 10%
code

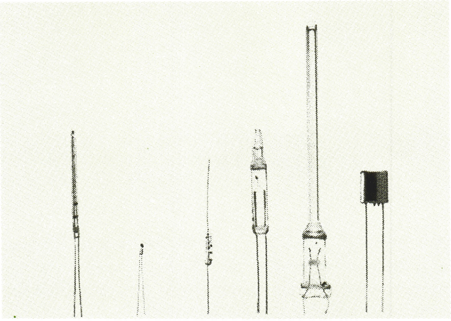
R_{25}		$B_{25/85}$ ± 5% K	code
680	Ω	2200 *	681
1	kΩ	2375 *	102
1,5		2500 *	152
2,2		2600 *	222
3,3		2750 *	332
4,7		3725	472
6,8		3775	682
10		3875	103
15		3800	153
22		3850	223
33		3800	333
47		3850	473
68		3900	683
100		3800	104
150		3880	154
220		3920	224
330		3980	334
470		4030	474
680		4100	684

* For 2322 627 2 . . . . tolerance 10%.

non-linear resistors

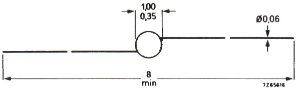
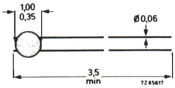
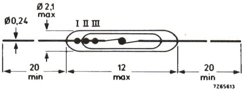
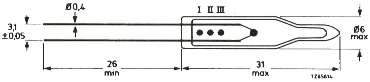
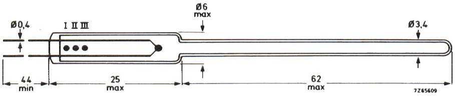
NTC thermistors

2322 634 – miniature beads



Resistance range

680 Ω – 680 kΩ (E6-series)

	dissipation max mW	dissipation factor mW/ °C	thermal time constant s	catalogue no. 2322 634 . . . . .
 1,00 0,35 Ø0,06 8 min 7Z65616	–	–	–	0
 1,00 0,35 Ø0,06 3,5 min 7Z65617	–	–	–	1
 Ø2,1 max Ø0,24 I II III 20 min 12 max 20 min 7Z65613	60	0,4	9	2
 Ø0,4 I II III 3,1 ±0,05 Ø6 max 26 min 31 max 7Z65614	20	0,11	6	3
 Ø0,4 I II III Ø6 max Ø3,4 44 min 25 max 62 max 7Z65609	–	–	–	4

tolerance on R_{25}:
20% = 1
10% = 2

For last three digits see code on previous page

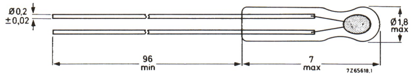
Coloured dots I, II, III stand for code in table see previous page

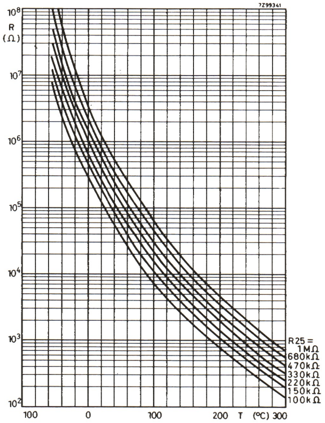
2322 627 31 – miniature bead
2322 628 – miniature bead indirectly heated

2322 627 31

Resistance range (E6 series) at 25 °C		100 kΩ to 1 MΩ
Dissipation	max	100 mW
$B_{25/85}$		3800 to 4200 K
Operating temperature		
at zero power		– 55 to +300 °C
at max power		0 to + 55 °C

R_{25} ± 20%	$B_{25/85}$ ± 5% K	catalogue no. 2322 627 31 . . .
100 kΩ	3800	104
150	3880	154
220	3920	224
330	3980	334
470	4030	474
680	4100	684
1 MΩ	4200	105

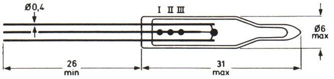


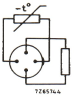


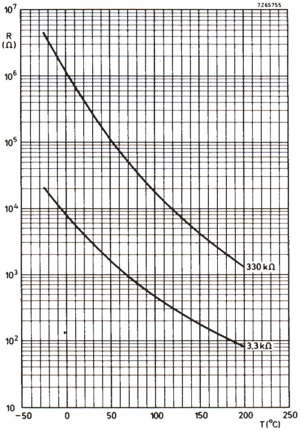
2322 628

Operating temperature			
at zero power		– 25 to +200 °C	
at max power		0 to + 55 °C	
Thermistor:	dissipation (W_h = 0) max	35	mW
	dissipation factor	0,18	mW/°C
	thermal time constant	15	s
Heater:	resistance (± 10%)	100	Ω
	dissipation (W_{th} = 0) max	35	mW

R_{25} ± 20% kΩ	$B_{25/85}$ K	colour code I	 II	 III	catalogue no.
3,3	2750	orange	orange	red	2322 628 01332
330	4275	orange	orange	yellow	2322 628 01334



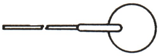
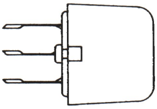
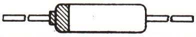
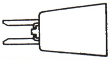
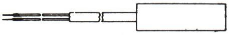




non-linear resistors

PTC thermistors — survey

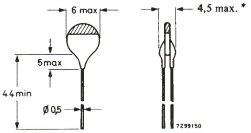
For detailed information
Handbook CM2a

type	R_{25} Ω	switch temperature °C	maximum voltage V	dissipation factor mW/°C	temperature coefficient %/°C	cat. no.	status	page
DISC								
	70 to 100	105	460 (r.m.s.)	11,5	35	2322 662 93006	D	C65
	250 ± 25%	6	25 (d.c.)	6	5	660 91001	D	C59
	50 to 60 ±30%	30 to 105	25 (d.c.)	7	7 to 40	660 91006 to 9	D	C59
	750 to 1500	115	245 (r.m.s.)	7	26	660 93001	D	C65
	30 to 50 ± 15 Ω	25 to 110	40–50 (d.c.)	6–8,5	9 to 75	661 91002 to 5	D	C60
	36 to 50	115	180 (d.c.)	13	35	662 91001	D	C61
	45 to 60	75	265 (r.m.s.)	20	20	662 93036	D	C61
	80 to 120	75	265 (r.m.s.)	15,3	35	662 93066	D	C61
	14 to 26	125	245 (r.m.s.)	21	28	663 93003	D	C66
	< 0,6	85	16 (d.c.)	27	10	664 91086	D	C66
	30 to 250	70 to 150	25 (d.c.)	5,7	18 to 38	672 91002 to 35	D	C67
DUAL DISC for degaussing 	25 and 8	75	245 (r.m.s.)	13,5	25	662 98001	D	C62
	30 and 8		265 (r.m.s.)		25	662 98003		
	6 and 3,5	75	140 (r.m.s.)	13,5	20	662 98006		
	1000 to 6000 and 40		265 (r.m.s.)			662 98009		
MINIATURE for level control 	70 to 250	160	19 (d.c.)	2 to 6	35	670 90023	D	C63
MOTOR PROTECTION DISC 		68 to 137	15 (d.c.)	7	18 to 38	672 92045 to 53	D	C63
DISC for compensation of telephone line variations 	115 ± 25	97	33 (d.c.)		> 10	672 98001	D	C64
HEATING ELEMENT 			240–265 (r.m.s.)			680 900 . .	D	C64
PTCs for overload protection	1,65 to 1500	115	60, 245, 265	3,5–20				C68-C69

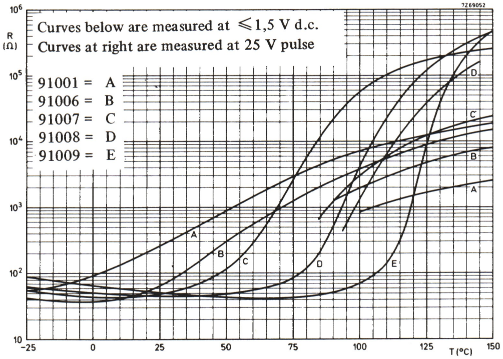
Catalogue no. 2322 660	91001	91006	91007	91008	91009	
Resistance at 25 °C; V(d.c.) ⩽ 1,5 V	250	60	50	50	50	Ω
tolerance	25	30	30	30	30	%
Switch temperature	6	30	50	80	105	°C
Temperature coefficient	5	7	16	23	40	%/°C
Thermal time constant	17	20	18	18	—	s
Dissipation factor	6	7				mW/°C
Max d.c. voltage	25	25				V
Operating temperature						
at zero power	− 25 to +155	−10 to +125				°C
at max voltage	0 to + 55	0 to + 55				°C

colour code

none	91001
red	91006
orange	91007
yellow	91008
green	91009



* For 91001 3,2 mm max.

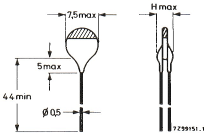


non-linear resistors

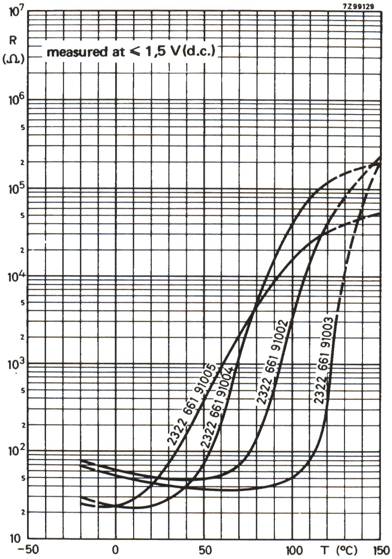
PTC thermistors

2322 661 — disc

Catalogue no. 2322 661	91002	91003	91004	91005	
Resistance at 25 °C; V(d.c.) ⩽ 1,5 V tolerance 15%	50	40	30	50	Ω
Switch temperature	80	110	45	25	°C
Temperature coefficient	18	75	16	9	%/°C
Thermal time constant	50	50	50	40	s
Dissipation factor	8,5	8,5	8,5	6	mW/°C
Max d.c. voltage	50	50	50	40	V
Operating temperature					
at zero power	−10 to +125				°C
at max voltage	0 to +55				°C

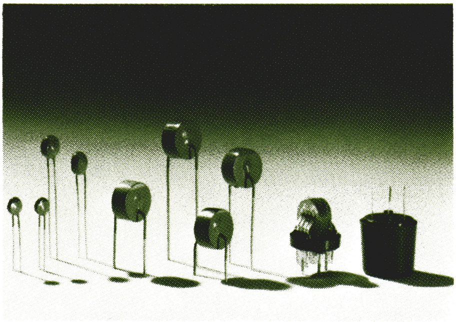


H_{max}
For 91002, 03, 04: 6 mm
For 91005: 5 mm



colour code

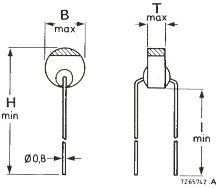
yellow	91002
green	91003
orange	91004
red	91005



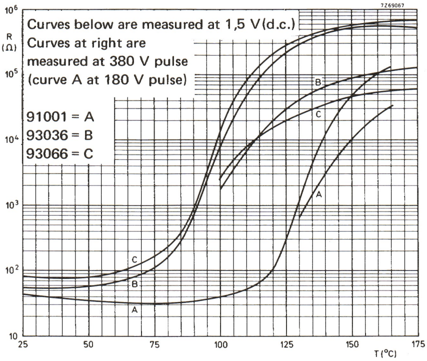
2322 662 – disc

662 91001 is designed for contact protection for telegraphy relays.
The other two PTC thermistors are used as the degaussing element in colour tv receivers, but have far wider applications as protective and delay devices.

Catalogue no. 2322 662	91001	93036	93066	
Resistance at 25 °C; V(d.c.) ⩽ 1,5 V	36–50	45–60	80–120	Ω
Switch temperature	115	75	75	°C
Temperature coefficient	35	20	35	%/ °C
Dissipation factor	13	20	15,3	mW/ °C
Max d.c. voltage	180	–	–	V
Max r.m.s. voltage	–	265	265	V
Operating temperature				
at zero power	0 to +155	– 25 to +155		°C
at max. voltage	0 to + 55	0 to + 60		°C



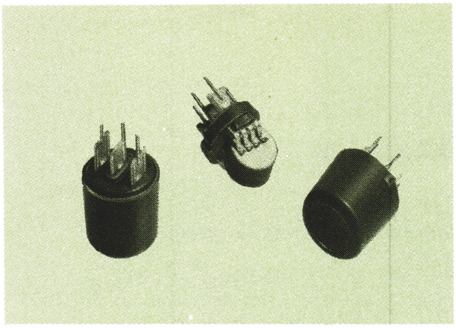
	colour code	T	B	H	l
91001	none	4,8	10,8	45	34
93036	green	6,5	12,6	51	38,4
93066	red	5,5	10,5	52	41,5



non-linear resistors

PTC thermistors

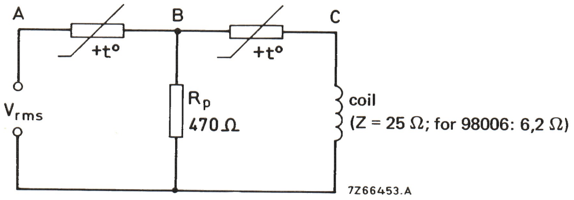
2322 662 98 — dual degaussing thermistors



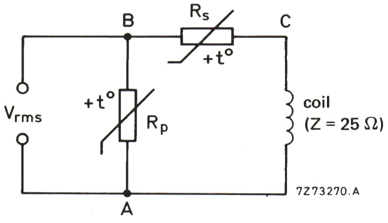
Intended for use in colour tv.
Because of the excellent thermal contact between the two discs inside the package, the stabilized current through the coil is limited to 2 mA.
The assembly is constructed for p.c.b. mounting.

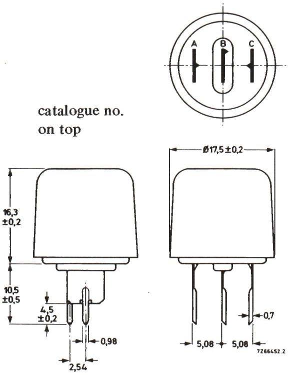
Catalogue no. 2322 662	98001	98003	98006	98009	
Resistance at 25 °C; V(d.c.) ⩽ 1,5 V					
mains PTC	25	30	6	1000 to 6000	Ω
coil PTC	8	8	3,5	40	Ω
Current through degaussing coil:					
min inrush peak current	5 (V_{rms} = 200 V)	5 (V_{rms} = 220 V)	9	5 (V_{rms} = 200 V)	A
max idle peak current after: 5 s	70	70	140	70	mA
30 s	5	5	10	5	mA
3 minutes	2	2	2	2	mA
Switch temperature	75	75	75	–	°C
Temperature coefficient	25	25	20	–	%/°C
Dissipation factor	13,5	13,5	13,5	–	mW/°C
Max r.m.s. voltage	245	265	140	265	V
Operating temperature					
at zero power	25 to +155			–25 to +125	°C
at max voltage	0 to +60			0 to +60	°C

Circuit diagrams
for 98001; 98003 and 98006

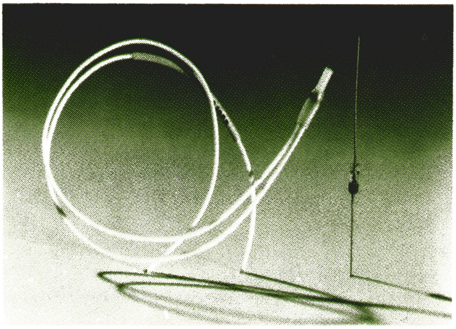

A
B
C
+t°
+t°
V_{rms}
R_p
470 Ω
coil
(Z = 25 Ω; for 98006: 6,2 Ω)
7Z66453.A

for 98009


B
R_s
C
+t°
V_{rms}
+t°
R_p
coil
(Z = 25 Ω)
A
7Z73270.A

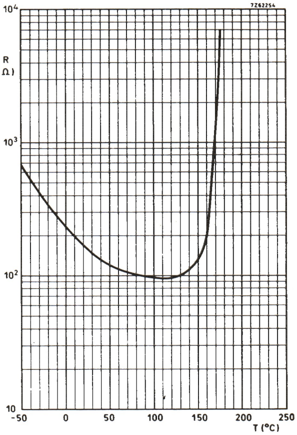

A
B
C
catalogue no.
on top
Ø17,5 ±0,2
16,3 ±0,2
10,5 ±0,5
4,5 ±0,2
0,98
2,54
0,7
5,08
5,08
7Z66452.2

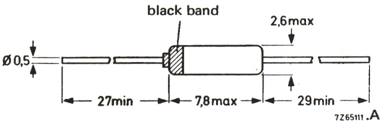
2322 670 90023 – for oil-tank measurements
2322 672 920 – for protection of motors against excessive temperatures



2322 670 90023

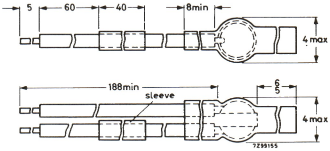
		still air –25 °C	still fuel oil + 50 °C	
Current at	12 V(d.c.)	⩽ 39	⩾ 45	mA
	16 V(d.c.)	⩽ 30	⩾ 36	mA
	18 V(d.c.)	⩽ 27	⩾ 33	mA
Dissipation factor		2	6.25	mW/ °C
Resistance at 25 °C		70 to 250		Ω
Max d.c. voltage at 75 °C		19		V
Switch temperature		160		°C
Temperature coefficient		35		% / °C
Operating temperature				
at zero power		– 55 to +125		°C
at max voltage:	still air	– 25 to + 75		°C
	still fuel oil	– 25 to + 50		°C





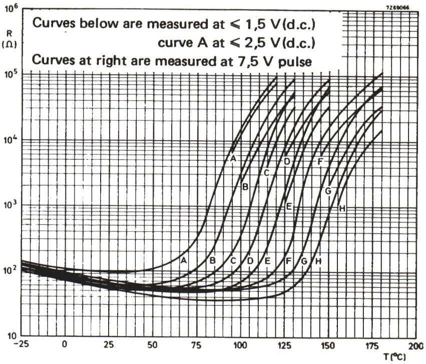
2322 672 920

Resistance at T_{ref}*	– 5 °C; V ⩽ 1,5 V(d.c.)	< 550	Ω
	+ 5 °C	> 1330	Ω
	+ 15 °C; V_{pulse} = 7,5 V	> 4000	Ω
Dissipation factor		7	mW/ °C
Max d.c. voltage		15	V
Operating temperature			
at zero power		– 20 to (T_{ref} +30) °C	
at max voltage		– 20 to (T_{ref} +15) °C	



last 5 digits of catalogue no. are printed on sleeve

T_{ref}* °C	T_{switch} °C	temperature coefficient %/°C	catalogue no.	curve
80	68	18	2322 672 92045	A
90	75	21	92046	B
100	88	31	92047	C
110	99	33	92048	D
120	113	38	92049	E
130	123	27	92051	F
140	130	33	92052	G
150	137	33	92053	H



Curves below are measured at ⩽ 1,5 V(d.c.)
curve A at ⩽ 2,5 V(d.c.)
Curves at right are measured at 7,5 V pulse

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* Temperature at which the thermistor makes the protective system operative.

non-linear resistors

PTC thermistors

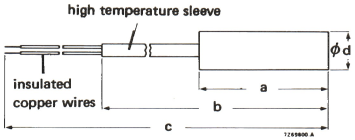
2322 680 900 — **heating elements**
2322 672 98001 — **telephone line current stabilizer (TPE)**

Heating elements with high initial dissipation going to a stabilized temperature (in standard test tube). Intended for hair curling tongs.

2322 680 900 . . heating elements

catalogue no. 2322 680		90011	90031	90058	90059	90061	90007	
voltage range (r.m.s.)		100 to 265	100 to 240	100 to 240	100 to 265	100 to 240	100 to 265	V
max inrush power	at 120 V	—	—	200	200	200	—	W
	at 220 V	500	500	—	—	—	500	W
approx. steady-state power (in test tube)	at 120 V	—	—	17	17	17	—	W
	at 220 V	17	15	—	—	—	low: 13	W
							med.: 16	W
							high: 18	W
temperature on test tube after 20 min	at 120 V	⩾ 145	⩾ 160	164 ± 8	158 ± 8	172 ± 8	low: 137±7,5	°C
							med.: 157±7,5	°C
							high: 167±7,5	°C
	at 220 V	161 ± 8	180 ± 8	—	—	—	low: 145±7,5	°C
							med.: 162±7,5	°C
							high: 173±7,5	°C
	at 240 V	—	—	⩽ 185	⩽ 180	⩽ 195	—	°C
insulation of coating		double	single	single	double	single	double	
dielectric withstanding voltage between terminals and coating (r.m.s.)		⩾ 6	⩾ 6	⩾ 6	⩾ 6	⩾ 6	⩾ 6	kV
dimensions	a	50 ± 2	60 ± 2	50 ± 2	50 ± 2	50 ± 2	50 ± 2	
	b	165 ± 7	no sleeve	no sleeve	100 ± 7	no sleeve	115 ± 7	
	c	260 ± 7	315 ± 10	155 ± 7	155 ± 7	245 ± 7	260 ± 7	
	d	$14{,}85^{+0}_{-0{,}25}$	$10{,}6^{+0{,}2}_{-0{,}2}$	$14{,}75^{+0}_{-0{,}25}$	$14{,}75^{+0}_{-0{,}25}$	$14{,}75^{+0}_{-0{,}25}$	$14{,}85^{+0}_{-0{,}25}$	
number of insulated copper wires		2	2	2	2	2	3	

2322 680 900



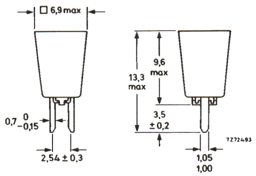
2322 672 98001 (TPE)

For resistances of up to 1000 Ω in telephone lines, the subscriber current will be within 31,5 mA and 48 mA.

Current compensation by selecting the right resistor is not necessary; it can be done automatically by a TPE.

Resistance at	25 °C	115 ± 25 Ω
	155 °C	> 15 kΩ
Switch temperature approx.		97 °C
Temperature coefficient		> 10% / °C
Max d.c. voltage		33 V
Operating temperature		
at zero power		−25 to +155 °C
at maximum voltage		+5 to + 55 °C

2322 672 98001

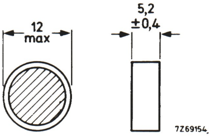


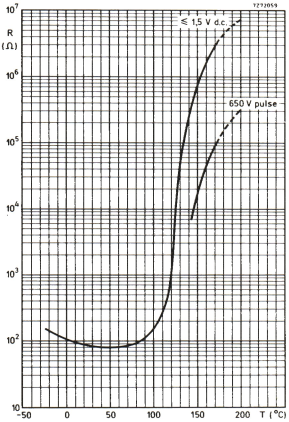
2322 662 93006 – discs
2322 660 93001

662 93006 is suitable for fluorescent lamp starter
660 93001 is suitable for stair-well lighting control

2322 662 93006

Resistance value at +25 °C	70 to 100 Ω
Resistance value at +200 °C V_{pulse} = 650 V	140 kΩ
Switch temperature	+100 to +110 °C
Temperature coefficient	+35%/ °C
Maximum r.m.s. voltage	400 V
Dissipation factor	11,5 mW/ °C
Operating temperature	
at zero power	–25 to +175 °C
at maximum voltage	0 to +85 °C

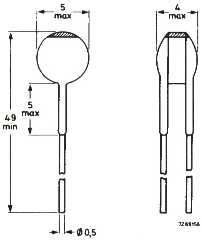


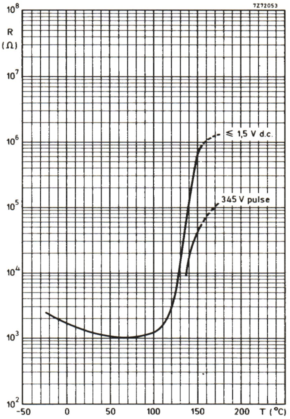


Typical resistance/temperature characteristics

2322 660 93001

Resistance value at +25 °C	750 to 1500 Ω
Resistance value at +175 °C V_{pulse} = 345 V	70 kΩ
Switch temperature	+115 °C
Temperature coefficient	+26% / °C
Maximum r.m.s. voltage	245 V
Dissipation factor	7 mW/ °C
Operating temperature	
at zero power	–25 to +155 °C
at maximum voltage	0 to +55 °C





non-linear resistors

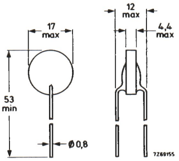
PTC thermistors

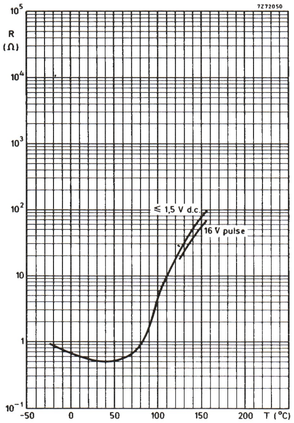
2322 663 93003 – discs
2322 664 91086

663 93003 is suitable for overheat protection in the ballast of a fluorescent lamp system.
664 91086 for protection purposes in relay coils, loudspeakers, etc.

2322 663 93003

Resistance value at +25 °C	14 to 26 Ω
Resistance value at +200 °C	
V_{pulse} = 345 V	min 20 kΩ
Switch temperature	+125 °C
Temperature coefficient	+28%/ °C
Maximum r.m.s. voltage	245 V
Dissipation factor	21 mW/ °C
Operating temperature	
at zero power	–25 to +175 °C
at maximum voltage	0 to +80 °C

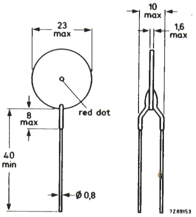


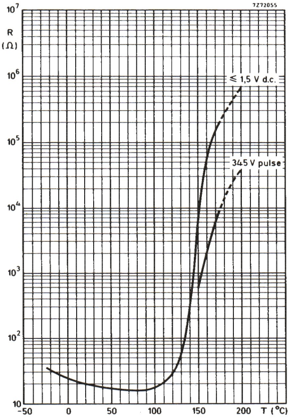


Typical resistance/temperature characteristics

2322 664 91086

Resistance value at +25 °C	max 0,6 Ω
Resistance value at +150 °C	
V_{pulse} = 16 V	min 40 Ω
Switch temperature	+85 °C
Temperature coefficient	+10%/ °C
Maximum d.c. voltage	16 V
Dissipation factor	27 mW/ °C
Operating temperature	
at zero power	–25 to +155 °C
at maximum voltage	–25 to + 55 °C

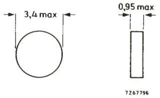




2322 672 91 — disc

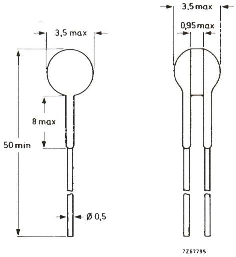
Intended as temperature sensors in domestic appliances, fire alarms, car electronics.

Resistance value between −20 and (T_s−10) °C		30 to 250 Ω
Resistance value at (T_s +25) °C and V_{pulse} = 7,5 V		⩾ 4000 Ω
Switch temperature, T_s		70 to 150 °C
Temperature coefficient		18 to 38%/ °C
Maximum d.c. voltage		25 V
Dissipation factor (version with leads)		5,7 mW/ °C
Operating temperature	at zero power	− 25 to (T_s +40) °C
	at maximum voltage	0 to (T_s +25) °C

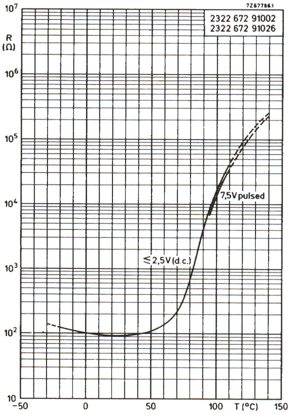


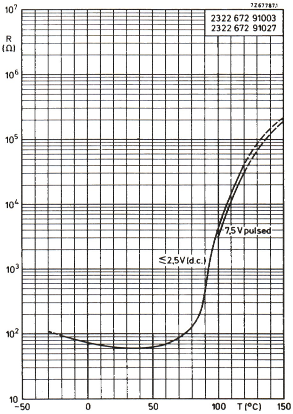
version without leads

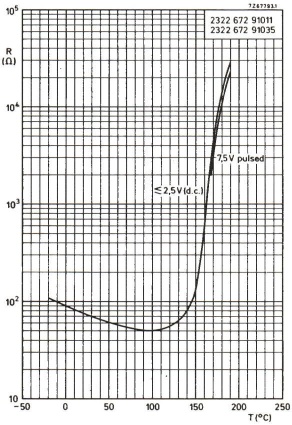
T_s °C	temperature coefficient %/ °C	balance voltage V(d.c.)	voltage dependence β at (T_s+25) °C	colour code for version with leads	catalogue no. 2322 672 ..... with leads	without leads
70	18	19	0,32	violet	91002	91026
80	21	27	0,40	grey	91003	91027
90	31	16	0,36	white	91004	91028
100	33	17	0,35	black	91005	91029
110	38	11	0,36	brown	91006	91031
120	27	34	0,38	red	91007	91032
130	33	13	0,34	orange	91008	91033
140	33	20	0,35	yellow	91009	91034
150	23	20	0,31	green	91011	91035



version with leads







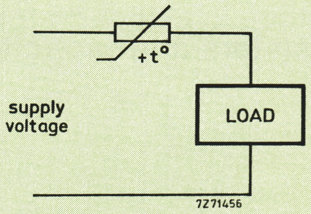
non-linear resistors

PTC thermistors for overload protection

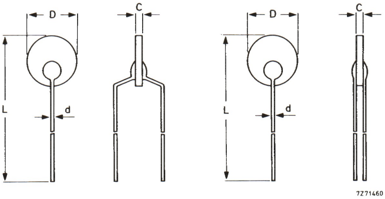
This range of PTCs is suitable for current-sensitive switching, or overload protection at current switching levels from the milliampere region to more than one ampere, with circuit supply voltages up to 240 V.

catalogue no.	R_{25}	T_s	V_{max}	I_{stat} peak		I_{max}	t_{resp} max	D	I_{res}	dimensions	
	(± 25%)		at 55 °C	at 25 °C	at 55 °C	at 0 °C and 60 V	at 25 °C and I_{max}				
2322 ...	Ω	°C	V	A	A	A	s	mW/ °C	mA	style	line
664 91002	1,65	115	60	0,85	0,64	7,5	3	20	65	a	6
664 91003	1,65	115	60	0,75	0,57	6,5	3	15	45	b	8
663 91002	2,3	115	60	0,63	0,47	5,25	3	15	52	a	7
663 91003	2,3	115	60	0,50	0,37	4,5	3	10	34	b	9
662 91006	3,7	115	60	0,44	0,33	3,5	3	12	41	a	8
662 91007	3,7	115	60	0,35	0,26	2,75	3	7,5	25	b	10
662 91004	5,6	115	60	0,34	0,25	2,7	3	11	31	a	9
662 91005	5,6	115	60	0,26	0,195	2	3	6,5	21	b	11
661 91019	9,4	115	60	0,25	0,19	1,9	3	10	28	a	10
661 91021	9,4	115	60	0,18	0,135	1,3	3	5	16	b	12
660 91017	25	115	60	0,09	0,068	0,65	3	4	11	b	13
672 91016	55	115	60	0,059	0,044	0,4	3	3,5	10	b	14

catalogue no.	R_{25}	T_s	V_{max}	I_{stat} peak		I_{max}	t_{resp} max	D	I_{res}	dimensions	
	(± 25%)		at 55 °C	at 25 °C	at 55 °C	at 0 °C and 245 V	at 25 °C and I_{max}				
2322 ...	Ω	°C	V	A	A	A	s	mW/ °C	mA	style	line
664 93014	3,7	115	245	0,55	0,41	4,9	6	20	18	a	1
664 93015	3,7	115	245	0,5	0,38	4,5	6	15,5	16	b	1
663 93006	6	115	245	0,4	0,3	3,0	6	16	16	a	2
663 93007	6	115	245	0,33	0,25	2,5	6	11	12	b	2
662 93017	10	115	245	0,27	0,2	1,8	7	12,5	14	a	3
662 93018	10	115	245	0,235	0,175	1,5	7	9	9	b	3
662 93015	15	115	245	0,215	0,162	1,3	7	11	13	a	4
662 93016	15	115	245	0,162	0,120	1	7	6,5	8	b	4
661 93001	25	115	245	0,150	0,115	0,9	7	10	12	a	5
661 93002	25	115	245	0,115	0,087	0,7	7	5,5	6	b	5
660 93006	70	115	245	0,059	0,045	0,25	8	4	5	b	6
660 93011	120	115	245	0,045	0,034	0,19	8	7	4,5	b	6
672 93003	150	115	245	0,036	0,027	0,1	8	4	3	b	7
660 93012	600	115	245	0,020	0,015	0,085	8	7	4	b	6
660 93013	1200	115	245	0,014	0,011	0,060	8	7	4	b	6
660 93014	1500	115	245	0,013	0,010	0,055	8	7	4	b	6



The principle of PTC overload protection.

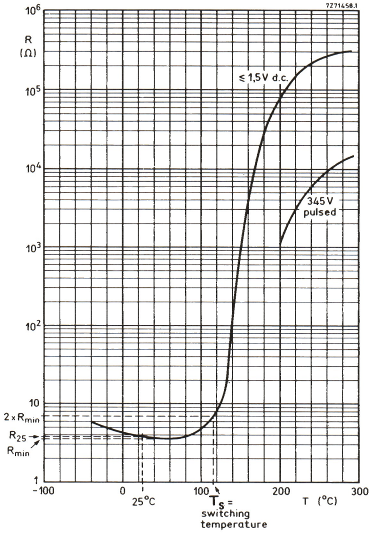


style a

style b

Style a

line	D	L	d	C_{max}
1	20	60	0,8	13
2	16	58	0,8	13
3	12	56	0,8	13
4	10	55	0,8	13
5	8	54	0,8	13
6	20	60	0,8	11
7	16	58	0,8	11
8	12	56	0,8	11
9	10	55	0,8	11
10	8	54	0,8	11



Resistance/temperature characteristic

Style b

line	D	L	d	C_{max}
1	20	60	0,5	5,5
2	16	58	0,5	5,5
3	12	56	0,5	5,5
4	10	55	0,5	5,5
5	8	54	0,5	5,5
6	4,5	52,5	0,5	5,5
7	3	51,5	0,5	5,5
8	20	60	0,5	4
9	16	58	0,5	4
10	12	56	0,5	4
11	10	55	0,5	4
12	8	54	0,5	4
13	4,5	52,5	0,5	4
14	3	51,5	0,5	4

standard series to IEC 63

values in a decade for resistors and capacitors

E192	E96	E48	E192	E96	E48	E192	E96	E48	E192	E96	E48	E192	E96	E48	E24	E12	E6	E3
100	100	100	169	169	169	284			481			816			10	10	10	10
101			172			287	287	287	487	487	487	825	825	825	11			
102	102		174	174		291			493			835			12	12		
104			176			294	294		499	499		845	845		13			
105	105	105	178	178	178	298			505			856			15	15	15	
106			180			301	301	301	511	511	511	866	866	866	16			
107	107		182	182		305			517			876			18	18		
109			184			309	309		523	523		887	887		20			
110	110	110	187	187	187	312			530			898			22	22	22	22
111			189			316	316	316	536	536	536	909	909	909	24			
113	113		191	191		320			542			920			27	27		
114			193			324	324		549	549		931	931		30			
115	115	115	196	196	196	328			556			942			33	33	33	
117			198			332	332	332	562	562	562	953	953	953	36			
118	118		200	200		336			569			965			39	39		
120			203			340	340		576	576		976	976		43			
121	121	121	205	205	205	344			583			988			47	47	47	47
123			208			348	348	348	590	590	590				51			
124	124		210	210		352			597						56	56		
126			213			357	357		604	604					62			
127	127	127	215	215	215	361			612						68	68	68	
129			218			365	365	365	619	619	619				75			
130	130					370			626						82	82		
132			221	221		374	374		634	634					91			
133	133	133	223			379			642									
135			226	226	226	383	383	383	649	649	649							
137	137		229			388			657									
138			232	232		392	392		665	665								
140	140	140	234			397			673									
142			237	237	237	402	402	402	681	681	681							
143	143		240			407			690									
145			243	243		412	412		698	698								
147	147	147	246			417			706									
149			249	249	249	422	422	422	715	715	715							
150	150		252			427			723									
152			255	255		432	432		732	732								
154	154	154	258			437			741									
156			261	261	261	442	442	442	750	750	750							
158	158		264			448			759									
160			267	267		453	453		768	768								
162	162	162	271			459			777									
164			274	274	274	464	464	464	787	787	787							
165	165		277			470			796									
167			280	280		475	475		806	806								

CONTENTS CAPACITORS

For detailed information
Handbook CM2b

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STANDARD SERIES	standard series to IEC 63	C70
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200
01

electrolytic and solid capacitors

survey

For detailed information
Handbook CM2b

type	capacitance range µF	rated voltage U_R V	series no. 2222 . . .	status	page
Aluminium electrolytic					
miniature/small, general purpose	0,33 to 15 000	6,3 to 100	030 to 033	D	C74–C75
long life	0,47 to 4 700	4 to 100	015 to 017	D	C76–C77
small, high voltage	1 to 220	160 to 400	041 to 043	N	C78–C79
bipolar	3,3 to 47	63	039	N	C80
very long life	2,2 to 2200	6,3 to 63	108	D	C81
large, long life	680 to 47 000	6,3 to 63	071 and 073	D	C82–C83
high voltage	68 to 680	250 and 375	084	D	C84–C85
screw terminals	220 to 1000	400	105	D	C86
long life and screw terminals	1500 to 150 000	6,3 to 100	106 and 107	D	C87
Solid aluminium					
small, long life, high stability	2,2 to 330	6,3 to 63	121	D	C88
miniature, long life, high stability, resin dipped	0,1 to 68	6,3 to 40	122	D	C89
Solid tantalum					
MIL, hermetic seal	0,1 to 330	6 to 75	141	D	C90–C91
standard, hermetic seal	0,1 to 330	6 to 50	143	D	C92
subminiature, resin dipped	0,01 to 68	1,6 to 25	146	D	C93

Packing of solid aluminium miniature capacitors.

electrolytic and solid capacitors

aluminium electrolytic

2222 030/031/032/033 – miniature/small general purpose

Low-voltage capacitors for consumer and general industrial applications.

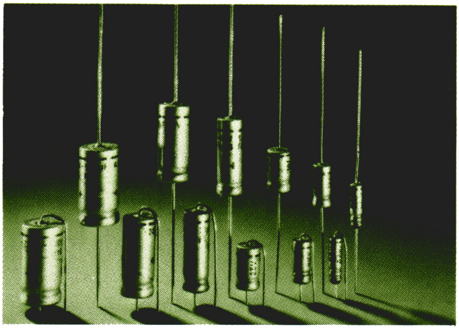
Nominal capacitance range (E6 series)	2,2 to 10 μF	0,33 to 1000 μF	68 to 4700 μF	330 to 15 000 μF
Tolerance on nominal capacitance	−10 to +100%	−10 to +50%	−10 to +50%	−10 to +50%
Rated voltage range, U_R (R5 series)	6,3 to 40 V	6,3 to 100 V	6,3 to 100 V	6,3 to 100 V
Case sizes	1	2, 3, 5a, 4, 5, 6, 7	00 to 03	04 to 06
Category temperature range	−25 to +70 °C	−25 to +85 °C	−40 to +85 °C	−40 to +85 °C
Endurance test at 85 °C, U_R applied	1000 h	1000 h	2000 h	1000 h
Basic specification	IEC 384-4, G.P. grade	IEC 384-4, G.P. grade	IEC 384-4, L.L.grade	IEC 384-4, G.P. grade
Climatic category IEC 68	25/070/56	25/085/56	40/085/56	40/085/56

Selection chart for C_{nom}–U_R and relevant case sizes

C_{nom} μF	U_R (V)						
	6,3	10	16	25	40	63	100
0,33						2	
0,47						2	
0,68						2	
1						2	2
1,5						2	
2,2					1	2	2
3,3				1		2	2
4,7			1			2	3
6,8		1			2	2	3
10	1			2	2	3	4, 5a
15			2		2	3	
22		2		2	3	4, 5a	5
33	2		2		3		6
47		2		3	4, 5a	5	7
68	2		3			6	00
100		3		4, 5a	5	7	01
150	3		4, 5a	5	6	00	02
220		4, 5a	5	6	7	01	03
330		5	6	7	01	02	04
470	5	6	7	00	01	02	05
680	6	7	00	01	02	03	06
1 000	7	00	01	02	03	05	
1 500	00	01	02	03	04	06	
2 200	01	02	03	04	05		
3 300	02	03	04	05	06		
4 700	03	04	05	06			
6 800	04	05	06				
10 000	05	06					
15 000	06						

Dimensions (mm)

case	style	d	l_1 min	l_2 min	D max	L max	P min
1	1	0,6			3,5	11	15
1	3	0,6			3,5	13	2,5
2	1	0,6			5,0	10,5	15
2	3	0,6			5,0	12,5	2,5
3	1	0,6			6,3	10,5	15
3	3	0,6			6,3	12,5	3,5
5a	1	0,6			8,5	11,5	15
5a	3	0,6			8,5	13	5
4	1	0,8			6,9	18,5	25
4	2,3	0,8			6,9	21,5	5
5	1	0,8			8,5	18,5	25
5	2,3	0,8			8,5	21,5	5
6	1	0,8			10,5	18,5	25
6	2,3	0,8			10,5	21,5	7,5
7	1	0,8			10,5	25	30
7	2,3	0,8			10,5	28	7,5
00	1	0,8	32	54	10,5	30,5	35
00	2,3	0,8			10,5	34	7,5
01	1	0,8	32	54	13	30,5	35
01	2,3	0,8			13	34	7,5
02	1	0,8	32	54	15,5	30,5	35
02	2,3	0,8			15,5	34	10
03	1	0,8	32	54	18,5	30,5	35
03	2,3	0,8			18,5	34	10
04	1	0,8	32	33	18,5	41,5	45
04	2	1,0			18,5	45	10
04	3	0,8			18,5	45	10
05	1	0,8	32	33	21,5	41,5	45
05	2	1,0			21,5	45	12,5
05	3	0,8			21,5	45	12,5
06	1	0,8	32	33	25,5	41,5	45



Composition of the catalogue no.

2222 03 . . . . . .

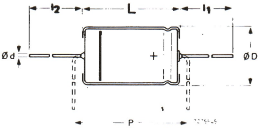
0 = case 1, 2, 3, 5a
1 = case 4, 5, 6, 7
2 = case 00, 01, 02, 03
3 = case 04, 05, 06

1 = 032 and 033, style 1, packed in box
2 = 030 and 031, style 1, taped on reel
3 = 030 and 031, style 1, taped in box
7 = style 2
8 = style 3

3 = U_R = 6,3 V
4 = 10 V
5 = 16 V
6 = 25 V
7 = 40 V
8 = 63 V
9 = 100 V

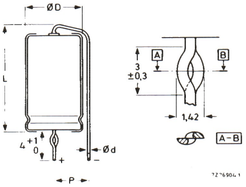
first two digits of capacitance value in μF

factor
7 = 0,01
8 = 0,1
9 = 1
1 = 10
2 = 100
3 = 1000



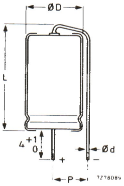
l2
L
l1
Ød
+
ØD
P

style 1
axial leads



ØD
L
A
B
3
±0,3
1,42
A–B
4 +1 0
+
–
Ød
P
7Z76904.1

style 2
single ended and
self locking

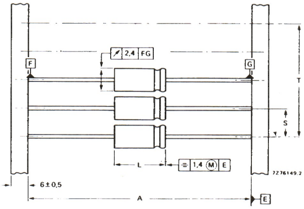


ØD
L
4 +1 0
+
Ød
P
7Z78084

style 3
single ended

case size	A	S	L_{max}	T	
				n < 50	50 < n < 100
1	63,5 ± 1,6	5 ± 0,4	11	5(n – 1) ± 2	5(n – 1) ± 4
2	63,5 ± 1,6	5 ± 0,4	10,5	5(n – 1) ± 2	5(n – 1) ± 4
3	63,5 ± 1,6	10 ± 0,4	10,5	10(n – 1) ± 2	10(n – 1) ± 4
5a	63,5 ± 1,6	10 ± 0,4	11,5	10(n – 1) ± 2	10(n – 1) ± 4
4, 5	73 ± 1,6	10 ± 0,4	18,5	10(n – 1) ± 2	10(n – 1) ± 4
6	73 ± 1,6	15 ± 0,75	18,5	15(n – 1) ± 2	15(n – 1) ± 4
7	73 ± 1,6	15 ± 0,75	25	15(n – 1) ± 2	15(n – 1) ± 4

n = number of capacitors.



2,4 FG
F
G
T
S
L
1,4 M E
7Z76149.2
6 ± 0,5
A
E

electrolytic and solid capacitors

aluminium electrolytic

2222 015/016/017 – miniature/small
long life

Low-voltage capacitors for general industrial applications.

Nominal capacitance range (E6 series)		0,47 to 4700 μF	
Tolerance on nominal capacitance		–10 to +50%	
Rated voltage range, U_R (R5 series)		4 to 100 V	
Case sizes	3, 5a		4, 5, 6, 7, 00 to 03
Category temperature range	–25 to +85 °C		–40 to +85 °C
Endurance test at 85 °C, U_R applied	1000 h		2000 h
Basic specification	IEC 384-4, G.P. grade		IEC 384-4 L.L. grade
Climatic category IEC 68	25/085/056		40/085/56

Selection chart for C_{nom}–U_R and relevant case sizes

C_{nom} μF	U_R (V)							
	4	6,3	10	16	25	40	63	100
0,47							3	
1							3	
1,5							3	
2,2							3	4
3,3							3	
4,7							3	4
6,8							3	
10							3	5
15						3	4/5a	
22					3	4/5a	5	6
33				3		4/5a		
47			3		4/5a	5	6	7
68		3		4/5a			7/00	
100	3		4/5a		5	6	01	
150		4/5a		5	6	7/00	01	
220	4/5a		5	6	7/00	01	02	
330	5		6	7/00			03	
470		6	7/00		01	02		
680		7/00		01	02	03		
1 000	00		01	02	03			
1 500		01	02	03				
2 200		02	03					
3 300		03						
4 700	03							

Dimensions (mm)

case	style	d	l_1 min	l_2 min	D max	L max	P min
3	1	0,6			6,3	10,5	15
3	3	0,6			6,3	12,5	3,5
5a	1	0,6			8,5	11,5	15
5a	3	0,6			8,5	13	5
4	1	0,8			6,9	18,5	25
4	2,3	0,8			6,9	21,5	5
5	1	0,8			8,5	18,5	25
5	2,3	0,8			8,5	21,5	5
6	1	0,8			10,5	18,5	25
6	2,3	0,8			10,5	21,5	7,5
7	1	0,8			10,5	25	30
7	2,3	0,8			10,5	28,5	7,5
00	1	0,8	32	54	10,5	30,5	35
00	2,3	0,8			10,5	34	7,5
01	1	0,8	32	54	13	30,5	35
01	2,3	0,8			13	34	7,5
02	1	0,8	32	54	15,5	30,5	35
02	2,3	0,8			15,5	34	10
03	1	0,8	32	54	18,5	30,5	35
03	2,3	0,8			18,5	34	10

Composition of the catalogue no.

2222 01 . . . . . .

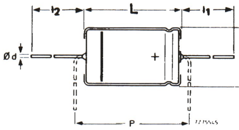
5 = case 3, 5a
6 = case 4, 5, 6, 7
7 = case 00, 01, 02, 03,

1 = 017, style 1, packed in box
2 = 015 and 016, style 1, taped on reel
3 = 015 and 016, style 1, taped in box
7 = 016 and 017, style 2
8 = style 3

2 = U_R = 4 V
3 = 6,3 V
4 = 10 V
5 = 16 V
6 = 25 V
7 = 40 V
8 = 63 V
9 = 100 V

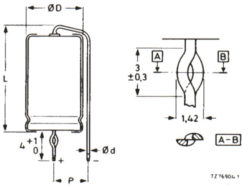
first two digits of
capacitance value
in μF

factor
7 = 0,01
8 = 0,1
9 = 1
1 = 10
2 = 100
3 = 1000



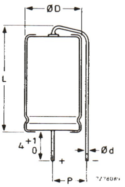
l2
L
l1
Ød
ØD
+
P
7Z75545

style 1
axial leads



ØD
L
4 +1 0
+
–
Ød
P
A
B
3 ±0,3
1,42
A–B
7Z76904.1

style 2
single ended and
self locking

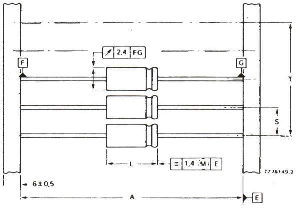


ØD
L
4 +1 0
+
–
Ød
P
7Z76085

style 3
single ended

case size	A	S	L_{max}	T n < 50	 50 < n < 100
3	63,5 ± 1,6	10 ± 0,4	10,5	10(n – 1) ± 2	10(n – 1) ± 4
5a	63,5 ± 1,6	10 ± 0,4	11,5	10(n – 1) ± 2	10(n – 1) ± 4
4, 5	73 ± 1,6	10 ± 0,4	18,5	10(n – 1) ± 2	10(n – 1) ± 4
6	73 ± 1,6	15 ± 0,75	18,5	15(n – 1) ± 2	15(n – 1) ± 4
7	73 ± 1,6	15 ± 0,75	25	15(n – 1) ± 2	15(n – 1) ± 4

n = number of capacitors.



2,4
FG
F
G
T
S
L
1,4 M
E
6±0,5
A
E
7Z76149.2

electrolytic and solid capacitors

aluminium electrolytic

2222 041/042/043 — small
high voltage

High-voltage capacitors for consumer and general industrial applications.

Nominal capacitance range (E3 series)	1 to 220 µF
Tolerance on nominal capacitance	−10 to +50%
Rated voltage range, U_R (R5 series)	160 to 400 V
Case sizes	4, 5, 6, 7, 00 to 06
Category temperature range	−40 to +85 °C
Endurance test at 85 °C, U_R applied	1000 h
Basic specification	IEC 384-4, G.P. grade
Climatic category IEC 68	40/085/56

Selection chart for C_{nom}—U_R and relevant case sizes

C_{nom} µF	U_R (V) 160	250	350	400
1				4
2,2		4		5
4,7	4	5	6	7
10	5	7	01	01
22	7	01	02	03
47	02	03	04	05
100	03	05	06	
220	05			

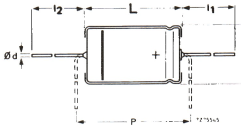
Dimensions (mm)

case	style	d	l_1 min	l_2 min	D max	L max	P min
4	1	0,8			6,9	18,5	25
4	2,3	0,8			6,9	21,5	5
5	1	0,8			8,5	18,5	25
5	2,3	0,8			8,5	21,5	5
6	1	0,8			10,5	18,5	25
6	2,3	0,8			10,5	21,5	7,5
7	1	0,8			10,5	25	30
7	2,3	0,8			10,5	28	7,5
00	1	0,8	32	54	10,5	30,5	35
00	2,3	0,8			10,5	34	7,5
01	1	0,8	32	54	13	30,5	35
01	2,3	0,8			13	34	7,5
02	1	0,8	32	54	15,5	30,5	35
02	2,3	0,8			15,5	34	10
03	1	0,8	32	54	18,5	30,5	35
03	2,3	0,8			18,5	34	10
04	1	0,8	32	33	18,5	41,5	45
04	2	1,0			18,5	45	10
04	3	0,8			18,5	45	10
05	1	0,8	32	33	21,5	41,5	45
05	2	1,0			21,5	45	12,5
05	3	0,8			21,5	45	12,5
06	1	0,8	32	33	25,5	41,5	45

Composition of the catalogue no.

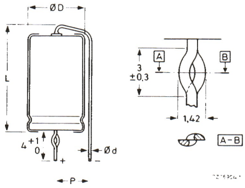
2222 04 . . . . . .

1 = case 4, 5, 6, 7 2 = case 00 to 03 3 = case 04 to 06	1 = 042 and 043, style 1, packed in box 2 = 041, style 1, taped on reel 3 = 041, style 1, taped in box 7 = style 2 8 = style 3	1 = U_R = 160 V 3 = 250 V 5 = 350 V 6 = 400 V	first two digits of capacitance value in μF	factor 8 = 0,1 9 = 1 1 = 10



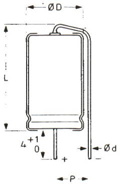
l_2
L
l_1
Ød
ØD
+
P
7Z75545

style 1
axial leads



ØD
L
4 +1 0
+
Ød
−
P
3 ±0,3
A
B
1,42
A−B

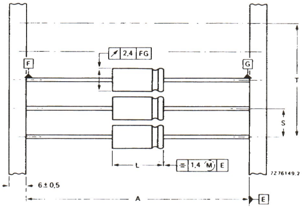
style 2
single ended and
self locking



style 3
single ended

case size	A	S	L_{max}	T n < 50	T 50 < n < 100
4, 5	73 ± 1,6	10 ± 0,4	18,5	10(n − 1) ± 2	10(n − 1) ± 4
6	73 ± 1,6	15 ± 0,75	18,5	15(n − 1) ± 2	15(n − 1) ± 4
7	83 ± 1,6	15 ± 0,75	25	15(n − 1) ± 2	15(n − 1) ± 4

n = number of capacitors.



F
G
2,4 FG
1,4 M E
L
T
S
6 ± 0,5
A
E
7Z76149.2

electrolytic and solid capacitors

aluminium electrolytic

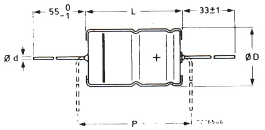
2222 039 – small
bipolar

63 V capacitors for general applications.

Nominal capacitance range (E6 series)	3,3 to 47 µF
Tolerance on nominal capacitance	−20 to +20%
Rated voltage U_R (a.c.) frequency > 15 Hz	63 V peak (40 V r.m.s.), provided ripple current remains within specified limits
Rated voltage U_R (d.c.)	63 V in both directions
Case sizes	00 to 03
Category temperature range	−40 to +85 °C
Endurance test at 85 °C	2000 h
Basic specification	IEC 384-4, L.L. grade
Category, IEC 68	40/085/56

Selection chart for C_{nom}–U_R and relevant case sizes

U_R V	C_{nom} µF	case size	nom. dimensions mm
63	3,3	00	ϕ 10 x 30
	4,7	00	ϕ 10 x 30
	6,8	00	ϕ 10 x 30
	10	01	ϕ 12,5 x 30
	15	01	ϕ 12,5 x 30
	22	02	ϕ 15 x 30
	33	02	ϕ 15 x 30
	47	03	ϕ 18 x 30



style 1
axial leads

Composition of the catalogue no.

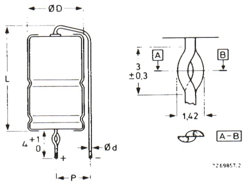
2222 039 . . . . .

1 = style 1
7 = style 2
8 = styel 3

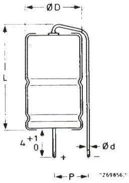
first two
digits of
capacitance
value in µF

factor: 8 = 0,1
9 = 1

UR
8 = 63 V



style 2
single ended and
self locking



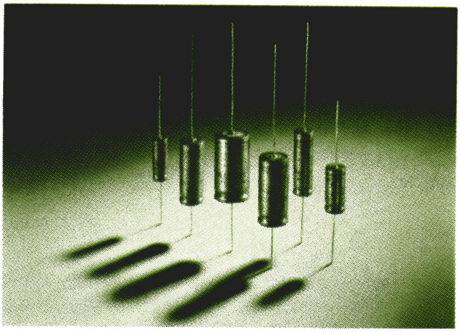
style 3
single ended

Dimensions (mm)

case size	d	D_{nom}	l_{nom}	style 1 D_{max}	style 1 L_{max}	style 1 P_{min}	styles 2 and 3 D_{max}	styles 2 and 3 L_{max}	styles 2 and 3 P
00	0,8	10	30	10,5	30,5	35	10,5	34	7,5-12,5
01	0,8	12,5	30	13,0	30,5	35	13,0	34	7,5-12,5
02	0,8	15	30	15,5	30,5	35	15,5	34	10 -15
03	0,8	18	30	18,5	30,5	35	18,5	34	10 -15

aluminium electrolytic

2222 108 — small
very long life



For long life applications.

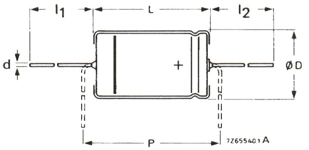
Nominal capacitance range (E6 series)		2,2 to 2200 μF
Tolerance on nominal capacitance		−10 to +50%
Rated voltage range, U_R (R5 series)		6,3 to 63 V
Case sizes		5, 6, 00 to 03
Category temperature range		−40 to +85 °C
Typical life time at 85 °C,	case sizes 5,6	> 7500 h
U_R applied	case sizes 00 to 03	> 10 000 h
Basic specifications		IEC 384-4, L.L. grade DIN 41240 (IA) DEF 5134-1 NF C 93-110 (type 1)
Climatic category	IEC 68	40/085/56
	DIN 40040	GPF (56 days)
	NF C 93-001	554

Selection chart for C_{nom}—U_R and relevant case sizes

C_{nom} μF	U_R (V)					
	6,3	10	16	25	40	63
2,2						5
3,3						5
4,7						5
6,8						5
10						5
15					5	6
22					5	6
33				5	6	00
47				5	6	00
68			5		00	01
100		5		6	01	02
150	5		6	00	01	03
220		6	00	01	02	
330	6	00			03	
470	00		01	02		
680		01	02	03		
1000	01	02	03			
1500	02	03				
2200	03					

Dimensions (mm)

case	d	l_1 min	l_2 min	D max	L max	P min
5	0,8	32	32	8,5	22,5	28
6	0,8	32	32	10,5	22,5	28
00	0,8	54	32	10,5	30,5	35
01	0,8	54	32	13,0	30,5	35
02	0,8	54	32	15,5	30,5	35
03	0,8	54	32	18,5	30,5	35



Composition of the catalogue no.

2222 108 . . . . .

1 = case 5,6
3 = 00 to 03

U_R
3 = 6,3 V
4 = 10 V
5 = 16 V
6 = 25 V
7 = 40 V
8 = 63 V

first two
digits of
capacitance
value in μF

factor: 8 = 0,1
9 = 1
1 = 10
2 = 100

electrolytic and solid capacitors

aluminium electrolytic

2222 071/073 — large
long life

For smoothing and decoupling purposes in industrial power supplies, where a long life and high ripple currents are required, and for coupling purposes in audio power circuits.

Nominal capacitance range (E6 series)	680 to 47 000 μF
Tolerance on nominal capacitance	−10 to +50%
Rated voltage range, U_R (R5 series)	6,3 to 63 V
Case sizes	5, 6(a), 7, 8(a), 9(a), 10
Category temperature range	−40 to +85 °C
Typical life time at 85 °C, U_R applied	> 5000 h
Basic specification	IEC 384-4 L.L. grade DIN 41238 (print version only)
Climatic category IEC 68	40/085/56

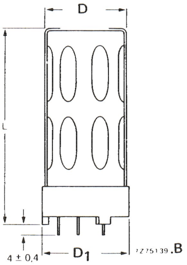
Selection chart for C_{nom}—U_R and relevant case sizes

C_{nom} μF	U_R (V) 6,3	10	16	25	40	63
680						5-6a
1 000					5-6a	6
1 500						7-8a
2 200				5-6a	6	8-9a
3 300			5-6a	6	7-8a	9
4 700		5-6a	6	7-8a	8-9a	10
6 800		6	7-8a	8-9a	9	
10 000	6	7-8a	8-9a	9	10	
15 000	7-8a	8-9a	9	10		
22 000	8-9a	9	10			
33 000	9	10				
47 000	10					

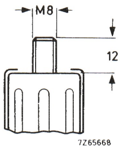
Dimensions (mm)

case size	style	D	D_1	L	L_1	P
5 *	1	21 + 0,6		50 + 1,3		13 ± 0,1
6a	1,2	25 + 0,6	27 + 1	40 + 1,3	45,5 ± 0,8	13 ± 0,1
6	1,2	25 + 0,6	27 + 1	50 + 1,3	55,5 ± 0,8	13 ± 0,1
7	1	25 + 0,6		80 + 1,3		13 ± 0,1
8a	1,3	30 + 0,6	32 + 1	50 + 1,3	55,8 ± 0,8	19 ± 0,1
8	1,3	30 + 0,6	32 + 1	80 + 1,3	84,7 ± 0,8	19 ± 0,1
9a	1,4	35 + 0,6	37 + 1	50 + 1,3	55,8 ± 0,8	19 ± 0,1
9	1,4	35 + 0,6	37 + 1	80 + 1,3	84,7 ± 0,8	19 ± 0,1
10	1,5	40 + 0,6	42 + 1	80 + 1,3	84,7 ± 0,8	19 ± 0,1

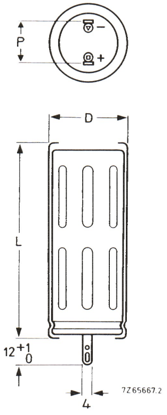
* Maintenance type.



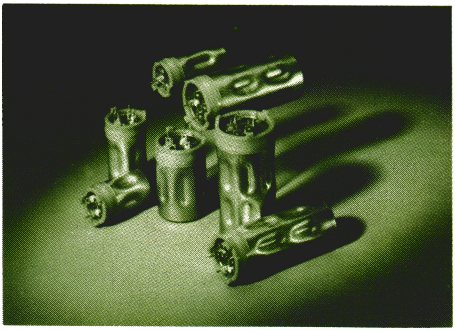
print version (styles 2, 3, 4, 5)



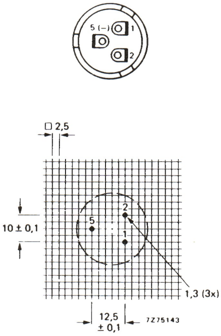
solder version
bolt mounting



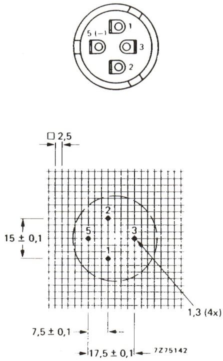
solder version (style 1)



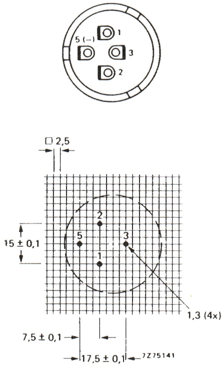
style 2
(D = 25)


5 (–)
1
2
□ 2,5
10 ± 0,1
5
2
1
1,3 (3x)
12,5
± 0,1
7Z75143

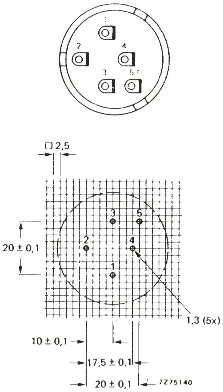
style 3
(D = 30)


5 (–)
1
3
2
□ 2,5
15 ± 0,1
2
5
3
1
1,3 (4x)
7,5 ± 0,1
17,5 ± 0,1
7Z75142

style 4
(D = 35)


5 (–)
1
3
2
□ 2,5
15 ± 0,1
2
5
3
1
1,3 (4x)
7,5 ± 0,1
17,5 ± 0,1
7Z75141

style 5
(D = 40)


2
4
3
5 (–)
□ 2,5
20 ± 0,1
3
5
2
4
1
1,3 (5x)
10 ± 0,1
17,5 ± 0,1
20 ± 0,1
7Z75140

Composition of the catalogue no.

2222 07 . . . . . .

case size
1 = 5, 6, 7, 8, 9, 10
3 = 6a, 8a, 9a

terminals
1 = solder tags
5 = print tags
6 = solder tags, bolt mounting
(not for case sizes 6a, 8a and 9a)

U_R
3 = 6,3 V
4 = 10 V
5 = 16 V
6 = 25 V
7 = 40 V
8 = 63 V

first two
digits of
capacitance
value in μF

factor
3 = 1000
2 = 100
1 = 10

Metal clamps, synthetic nuts for bolt version, and rubber washers for insulated mounting are also available.

electrolytic and solid capacitors

aluminium electrolytic

2222 084 — large
high voltage

For smoothing, coupling and decoupling purposes in television and audio circuits.

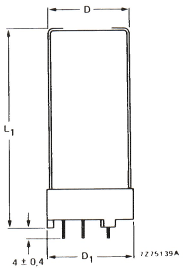
Nominal capacitance range (E6 series)	68 to 680 μF
Tolerance on nominal capacitance	−10 to +50%
Rated voltage range, U_R	250 and 375 V
Case sizes	6(a), 7, 8(a), 9(a), 10(a)
Category temperature range	−25 to +70 °C
Endurance test at 70 °C, U_R applied	1000 h
Basic specification	IEC 384-4, G.P. grade
Climatic category IEC 68	25/070/56
Detail specification (mechanical)	DIN 41238

Dimensions (mm)

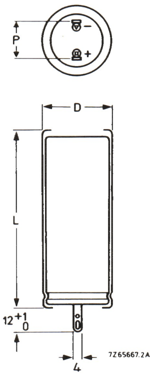
case	style	D	D_1	L	L_1	P
6a	1,2	25 + 0,6	27 + 1	40 ± 1,3	45,5 ± 0,8	13 ± 0,1
6	1,2	25 + 0,6	27 + 1	50 ± 1,3	55,5 ± 0,8	13 ± 0,1
7	1	25 + 0,6		80 ± 1,3		13 ± 0,1
8a	1,3	30 + 0,6	32 + 1	50 ± 1,3	55,5 ± 0,8	19 ± 0,1
8	1,3	30 + 0,6	32 + 1	80 ± 1,3	84,7 ± 0,8	19 ± 0,1
9a	1,4	35 + 0,6	37 + 1	50 ± 1,3	55,8 ± 0,8	19 ± 0,1
9	1,4	35 + 0,6	37 + 1	80 ± 1,3	84,7 ± 0,8	19 ± 0,1
10a	1,5	40 + 0,6	42 + 1	50 ± 1,3	55,8 ± 0,8	19 ± 0,1
10	1,5	40 + 0,6	42 + 1	80 ± 1,3	84,7 ± 0,8	19 ± 0,1

Selection chart for C_{nom}—U_R and relevant case sizes single capacitors

C_{nom} μF	U_R = 250 V solder tags	U_R = 250 V print tags	U_R = 375 V solder tags	U_R = 375 V print tags
68	—	—	6a	6a
100	6a	6a	—	—
150	6	6	7	8a
220	7	8a	8	9a
330	8	9a	9	9
470	10a	10a	10	10
680	9	9	—	—



print versions
(styles 2, 3, 4, 5)



solder versions
(style 1)

Composition of the catalogue no. for single types

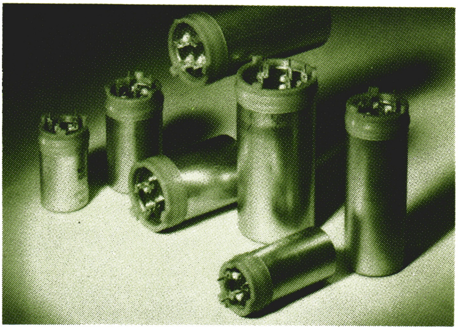
2222 084 . . . . .

1 = solder tags
5 = print tags

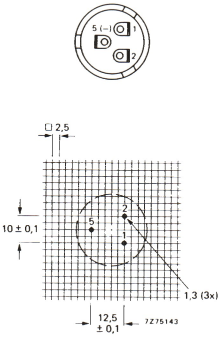
U_R
3 = 250 V
8 = 375 V

first two digits of capacitance value in μF

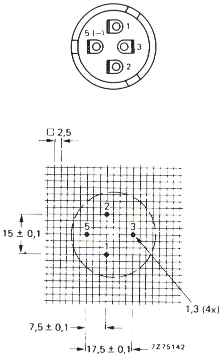
factor
9 = 1
1 = 10
2 = 100



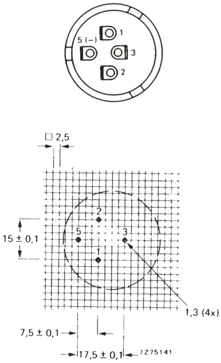
style 2
(D = 25)


5 (−)
1
2
□ 2,5
10 ± 0,1
5
2
1
1,3 (3x)
12,5
± 0,1
7Z75143

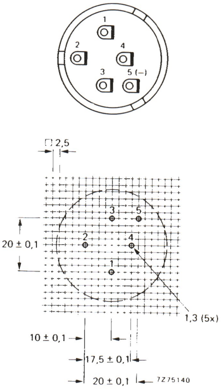
style 3
(D = 30)


5 (−)
1
3
2
□ 2,5
15 ± 0,1
2
5
3
1
1,3 (4x)
7,5 ± 0,1
17,5 ± 0,1
7Z75142

style 4
(D = 35)


5 (−)
1
3
2
□ 2,5
15 ± 0,1
2
5
3
1
1,3 (4x)
7,5 ± 0,1
17,5 ± 0,1
7Z75141

style 5
(D = 40)


1
2
4
3
5 (−)
□ 2,5
20 ± 0,1
3
5
2
4
1
1,3 (5x)
10 ± 0,1
17,5 ± 0,1
20 ± 0,1
7Z75140

Selection chart C_{nom}—U_R, relevant case sizes and connections. Double and triple capacitors, print versions only. Pin 5 is negative.

C_{nom} (µF)				case sizes		code in catalogue no.
pin 1	pin 2	pin 3	pin 4	U_R = 250 V	U_R = 375 V	
100	47			6	8a	429
100	100			8a	9a	449
220	22			9a	10a	619
220	220			10a	10	669
47	47	47			8a	222
100	100	47		9a	9	442
220	47	47		9a	9	622
220	100	100		10a	10	644
470	100	100		9		844

Composition of the catalogue no. for double and triple types

2222 084 . . . . .

7 = double and
triple types

U_R
3 = 250 V
8 = 375 V

code for capacitance values, see chart

electrolytic and solid capacitors

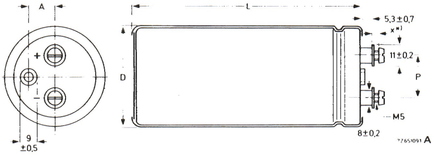
aluminium electrolytic

2222 105 — large
screw terminals

Nominal capacitance range (E6 series)	220 to 1000 μF
Tolerance on nominal capacitance	−10 to +30%
Rated voltage, U_R, at < 60 °C	400 V
Derated voltage, 0,94 x U_R, at 60 to 85 °C	375 V
Case sizes	11, 12, 14 to 16
Category temperature range	−25 to +85 °C
Endurance test at 85 °C, U_R applied	2000 h
Basic specification	IEC 384-4, L.L. grade
Climatic category, IEC 68, at U_R	25/060/56
at 0,94 x U_R	25/085/56

Dimensions (mm)

U_R V	C_{nom} μF	case size	D +1,5	L +3	P ± 0,1	A ± 0,2
	220	11	35	80	15	8,4
	330	12	35	112	15	8,4
400	470	14	50	80	22	14,3
	680	15	50	112	22	14,3
	1000	16	65	112	31	19,0



Mounting accessories are available.

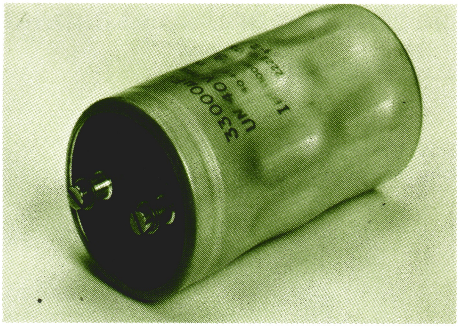
Composition of the catalogue no.

2222 105 16 . . .

first two digits of
capacitance value in μF

factor: 1 = 10
2 = 100

2222 106/107 — large
long life — screw terminals



For industrial and military applications.

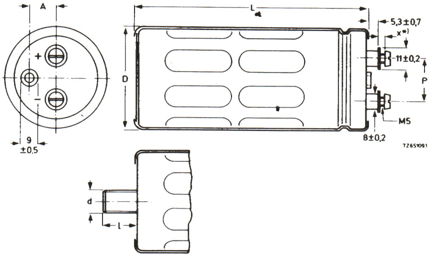
Nominal capacitance range (E6 series)	1500 to 150 000 μF
Tolerance on nominal capacitance	−10 to +50%
Rated voltage, U_R, (R5 series)	6,3 to 100 V
Case sizes	11, 12, 14 to 16
Category temperature range, 2222 106	−40 to +85 °C
2222 107	−25 to +85 °C
Typical life time at 85 °C, U_R applied	> 5000 h
Basic specification	IEC 384-4 L.L. grade
Climatic category IEC 68 2222 106	40/085/56
DIN 40040	GPF (56 days)
NF C93-001	554
IEC 68 2222 107	25/085/56
DIN 40040	HPF (56 days)
NF C93-001	654

Selection chart for C_{nom}—U_R and relevant case sizes

C_{nom} μF	U_R (V) 6,3	10	16	25	40	63	100
1 500							11
2 200						11	12
3 300						12	14
4 700					11	14	15
6 800				11	12	15	
10 000			11	12	14		16
15 000		11	12	14	15	16	
22 000	11	12	14	15			
33 000	12	14	15		16		
47 000	14	15		16			
68 000	15		16				
100 000		16					
150 000	16						

Dimensions (mm)

case size	D +1,5	L +3	P ± 0,1	A ± 0,2	d x l
11	35	80	15	8,4	M8 x 12
12	35	112	15	8,4	M8 x 12
14	50	80	22	14,3	M12 x 16
15	50	112	22	14,3	M12 x 16
16	65	112	31	19,0	M12 x 16



Composition of the catalogue no.

2222 10 . . . . .

6 = 6,3-10-16-25-40-63 V
7 = 100 V

mounting
3 = clamp version
5 = bolt version

U_R
3 = 6,3 V
4 = 10 V
5 = 16 V
6 = 25 V
7 = 40 V
8 = 63 V
0 = 100 V

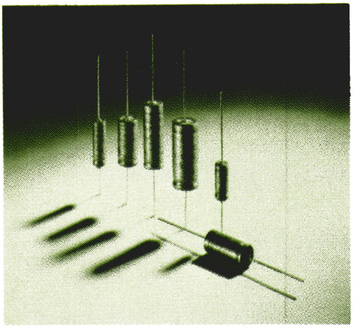
first two digits of capacitance value in μF

factor
2 = 100
3 = 1000
4 = 10000

electrolytic and solid capacitors

solid aluminium

2222 121 — small
long life — high stability



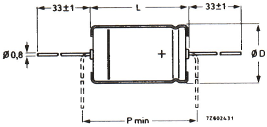
Nominal capacitance range (E6 series)	2,2 to 330 μF
Tolerance on nominal capacitance	−20 to +20%
Rated voltage range, U_R (R5 series)	6,3 to 40 V
Case sizes	**1 to 6**
Category temperature range	−55 to +125 °C
Endurance test at 125 °C, U_R applied	5000 h
Typical life time at 125 °C	> 10 000 h
Basic specification	IEC 384-4 L.L. grade
Climatic category IEC 68 at U_R	55/085/56
at 0,63 x U_R	55/125/56

Selection chart for C_{nom}–U_R and relevant case sizes

C_{nom} μF	U_R (V)				
	6,3	10	16	25	40
2,2					1
3,3					1
4,7				1	2
6,8					2
10			1	2	3
15		1	2		
22	1			3	4
33		2	3	4	5
47	2	3	4	5	6
68	3		5	6	
100		4	6		
150	4	5			
220	5	6			
330	6				

Dimensions (mm)

case size	D_{max}	L_{max}	P_{min}
1	6,6	17,5	20
2	6,6	24	27,5
3	8,3	24	27,5
4	10,4	24	27,5
5	10,4	32	35
6	12,9	32	35

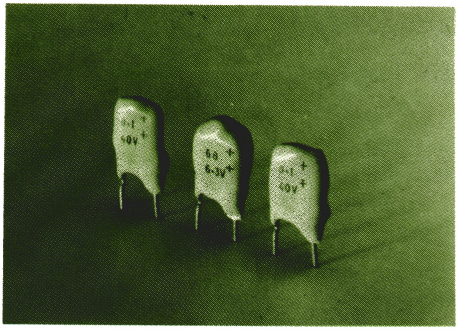


Composition of the catalogue no.

2222 121 1 . . . .

U_R		first two digits of capacitance value in μF	factor
3 = 6,3 V	6 = 25 V		8 = 0,1
4 = 10 V	7 = 40 V		9 = 1
5 = 25 V			1 = 10

2222 122 – miniature
long life – high stability – resin dipped
extremely low leakage current



Nominal capacitance range (E6 series)	0,1 to 68 μF
Tolerance on nominal capacitance	–20 to +40%, ± 20% on request
Rated voltage range, U_R (R5 series)	6,3 to 40 V
Case sizes	1 to 4
Category temperature range	–55 to +125 °C
Endurance test at 85 °C, U_R applied	5000 h
Basic specification	IEC 384-4, L.L. grade
Climatic category IEC 68	55/125/56

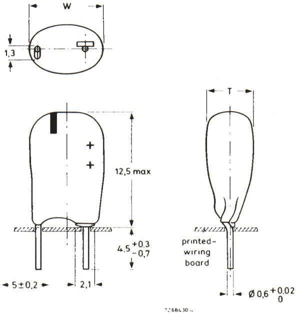
Selection chart for C_{nom}–U_R and relevant case sizes

C_{nom} μF	U_R (V) 6,3	10	16	25	40*
0,1					1
0,15					1
0,22					1
0,33					1
0,47					2
0,68				1	2
1				1	3
1,5				1	4
2,2			1	2	
3,3			1	2	
4,7		1	2	3	
6,8		1	2	4	
10	1	2	3		
15	1	2	4		
22	2	3			
33	3	4			
47	4				
68	4				

* 85 °C < T ⩽ 125 °C: 25 V.

Dimensions (mm)

case size	W_{max}	T_{max}	P_{min}
1	8	3,5	5
2	8	4,5	5
3	8	5	5
4	8	6	5



Composition of the catalogue no.

2222 122 5 . . . .

U_R
3 = 6,3 V
4 = 10 V
5 = 16 V
6 = 25 V
7 = 40 V

first two digits of capacitance value in μF

factor
7 = 0,01
8 = 0,1
9 = 1

electrolytic and solid capacitors

solid tantalum

2222 141 – MIL
metal case – hermetic seal

Established reliability, MIL-C-39003, style CSR13.
Hermetic seal tubular case, axial leads.

Nominal capacitance range (E12 series)	0,1 to 330 µF
Tolerance on nominal capacitance	± 20%, ± 10%
Rated voltage range, U_R	6 to 75 V
Case sizes	A, B, C, D
Category temperature range at U_R	−55 to +85 °C
at 0,67 x U_R	−55 to +125 °C
Basic specification	MIL-C-39003/01, style CSR 13
Climatic category, IEC 68 at U_R	55/085/56
at 0,67 x U_R	55/125/56

Selection chart for C_{nom}–U_R and relevant case sizes.

C_{nom} µF	U_R (V) 10	15	20	50	75
0,1				A	A
0,12				A	A
0,15				A	A
0,18				A	A
0,22				A	A
0,27				A	A
0,33				A	A
0,39				A	A
0,47				A	A
0,56				A	A
0,68				A	A
0,82				A	B
1				A	B
1,2			A	B	B
1,5			A	B	B
1,8			A	B	B
2,2			A	B	B
2,7		A		B	B
3,3		A		B	B
3,9	A			B	B
4,7	A			B	C

C_{nom} µF	U_R (V) 6	10	15	20	35	50	75
5,6	A				B	C	C
6,8	A				B	C	C
8,2				B		C	C
10				B		C	C
12				B		C	D
15				B		C	D
18			B			C	
22			B		C	D	
27		B		C	D		
33		B		C	D		
39		B		C	D		
47	B			C	D		
56	B		C	D			
68			C	D			
82		C		D			
100		C		D			
120		C	D				
150	C		D				
180	C	D					
220		D					
270	D						
330	D						

Composition of the catalogue no.

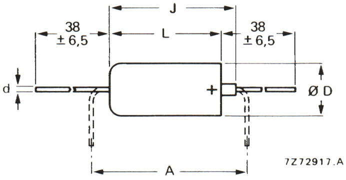
2222 141 . . . . .

dash number of
failure rate level
to MIL-C-39003/1E

case size
1 = case A
2 = case B
3 = case C
4 = case D

Dimensions (mm)

case size	A	D		L		J_{max}	d	
A	12,7	3,43	+ 0,41 − 0,38	7,26	± 0,79	10,72	0,51	± 0,05
B	17,8	4,70		12,04		15,49	0,51	
C	25,4	7,34		17,42		20,88	0,64	
D	27,9	8,92		19,96		23,42	0,64	



MILITARY CODING SYSTEM

CSR13 F 476 K P

Failure rate level in %/1000 h
L = 2 P = 0,1 S = 0,001
M = 1 R = 0,01

Tolerance on C_{nom}
K = ± 10%
M = ± 20%

Capacitance
Nominal capacitance in **pF**. First two digits are significant figures, third figure is number of zeros to follow.
Example: 476 means 47 μF, 475 means 4,7 μF

Rated voltage −55 to +85 °C
B = 6 V F = 35 V
C = 10 V G = 50 V
D = 15 V H = 75 V
E = 20 V J = 100 V

Style, CSR13
Established reliability sintered tantalum anode solid electrolyte capacitor. Insulated case only.

Note: Military number does not **designate** case size.
Use selection chart for C_{nom}−U_R for available case sizes.

2222 143 — standard
metal case — hermetic seal

Nominal capacitance range (E6 series)		0,1 to 330 µF
Tolerance on nominal capacitance		± 20%, ± 10%
Rated voltage range U_R		6 to 50 V
Case sizes		A, B, C, D
Category temperature range	at U_R	−55 to +85 °C
	at 0,67 x U_R	−55 to +125 °C
Endurance test at 85 °C, U_R applied		2000 h
Basic specification		MIL-C-39003
Climatic category, IEC 68	at U_R	55/085/56
	at 0,67 x U_R	55/125/56

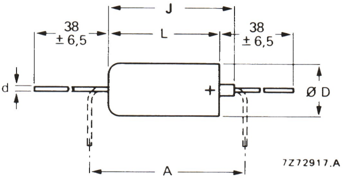
Dimensions (mm)

case size	A	D		L		J_{max}	d	
A	12,7	3,43	+ 0,41 − 0,38	7,26	± 0,79	10,72	0,51	± 0,05
B	17,8	4,70		12,04		15,49	0,51	
C	25,4	7,34		17,42		20,88	0,64	
D	27,9	8,92		19,96		23,42	0,64	

Composition of the catalogue no.

2222 143 . . . . .

tolerance on capacitance	U_R	first two digits of capacitance value in µF	factor
1 = ± 20%	3 = 6 V		1 = 10
8 = ± 10%	4 = 10 V		9 = 1
	5 = 15 V		8 = 0,1
	6 = 20 V		7 = 0,01
	7 = 35 V		
	8 = 50 V		



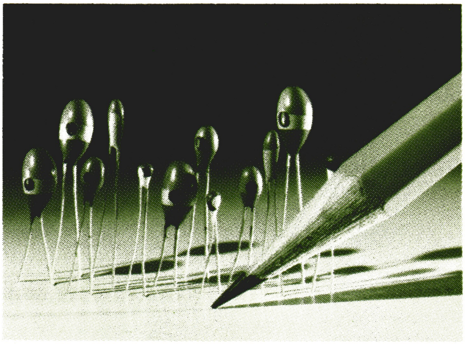
Selection chart for C_{nom}—U_R and relevant case sizes

C_{nom} µF	U_R (V)					
	6	10	15	20	35	50
0,1					A	A
0,12					A	A
0,15					A	A
0,18					A	A
0,22					A	A
0,27					A	A
0,33					A	A
0,39					A	A
0,47					A	A
0,56					A	A
0,68					A	A
0,82					A	A
1					A	A
1,2				A	B	B
1,5				A	B	B
1,8				A	B	B
2,2				A	B	B
2,7			A		B	B
3,3			A		B	B
3,9		A			B	B
4,7		A			B	B
5,6	A				B	C

C_{nom} µF	U_R (V)					
	6	10	15	20	35	50
6,8	A				B	C
8,2				B	C	C
10				B	C	C
12				B	C	C
15				B	C	C
18			B		C	C
22			B		C	D
27		B		C	D	
33		B		C	D	
39		B		C	D	
47	B			C	D	
56	B		C	D		
68			C	D		
82		C		D		
100		C		D		
120		C	D			
150	C		D			
180	C	D				
220		D				
270	D					
330	D					

2222 146 – subminiature resin dipped

These capacitors are eminently suitable for use in electronic circuitry and are especially designed for those applications where extremely small dimensions are an absolute must and also a high stability and reliability are required, such as hearing-aids, electronic watches and paging systems.



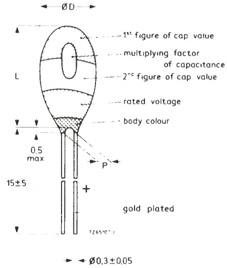
Nominal capacitance range (E6 series)	0,01 to 68 μF
Tolerance on nominal capacitance	–20 to +20%
Rated voltage range, U_R (R5 series)	1,6 to 25 V
Category temperature range	–55 to + 85 °C
Endurance test at 85 °C, U_R applied	2000 h
Climatic category IEC 68	55/085/21

Dimensions (mm)

case size	D max	L max	P ± 0,3
1	2	2,7	1
2	2	4	1
3	2	4,9	1
4	3,2	4,5	1,1
5	4	7,5	1,2

Selection chart for C_{nom}–U_R and relevant case sizes

C_{nom} μF	U_R (V) 1,6	2,5	4	6,3	10	16	25
0,01							1
0,015							1
0,022							1
0,033							1
0,047							1
0,068							1
0,1							1
0,15							1
0,22						1	2
0,33					1		2
0,47				1		2	3
0,68			1		2		3
1,0		1		2		3	4
1,5	1		2		3		4
2,2	1	2		3		4	5
3,3	2		3		4		5
4,7	2	3		4			5
6,8	3		4			5	
10	3	4			5		
15	4			5			
22	4		5				
33		5					
47	5						
68	5						


ØD
1st figure of cap value
multiplying factor of capacitance
2nd figure of cap value
L
rated voltage
body colour
0.5 max
P
15±5
+
gold plated
7Z65107.2
Ø0.3±0.05

value figs (μF) 1st	2nd	multiplier	U_R V	colour code
–	0	1	10	black
1	1	–	1,6	brown
2	2	–	4	red
3	3	–	–	orange
4	4	–	6,3	yellow
5	5	–	16	green
6	6	–	–	blue
7	7	0,001	–	violet
8	8	0,01	25	grey
9	9	0,1	2,5	white

Composition of the catalogue no.

2222 146 1 . . . .

U_R
0 = 1,6 V
1 = 2,5 V
2 = 4 V
3 = 6,3 V
4 = 10 V
5 = 16 V
6 = 25 V

first two digits of capacitance value in μF

factor
6 = 0,001
7 = 0,01
8 = 0,1
9 = 1

film capacitors

survey

Metallized film capacitors

For detailed information
Handbook CM2b

main application	description	dielectric	rated voltage	rated capacitance	series no.	status	page
discharge	sealed aluminium case; solder tags	metallized polypropylene film	250 V (r.m.s.)	3 to 22,5 μF	328	N	C96
coupling and decoupling	moulded; axial leads	metallized PETP film or metallized polycarbonate film	100, 250 400, 630 1000, 1600 V (d.c.)	0,001 to 6,8 μF	341	D	C97
coupling and decoupling	potted; radial leads	metallized PETP film or metallized polycarbonate film	63, 100, 250 400, 630 V (d.c.)	0,0039 to 10 μF	344	D	C98-C99
coupling and decoupling	lacquered; radial leads	metallized PETP film	100, 250 400, 630 V (d.c.)	0,001 to 6,8 μF	352	D	C100-C101
interference suppression	moulded; axial leads potted; radial leads	paper/metallized PETP film	250 V (r.m.s.)	0,01 to 0,33 μF	330	N	C102
deflection	moulded; axial leads potted; radial leads	paper/metallized polycarbonate film	210 V (d.c.)	0,82 to 3,3 μF	363	D	C103

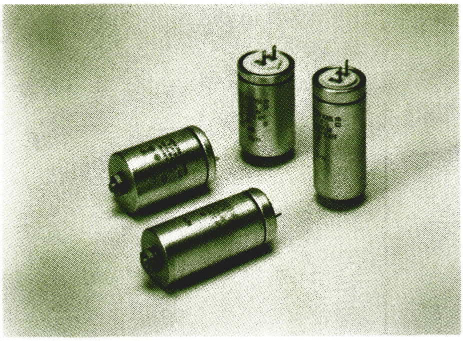
Film/foil capacitors

main application	description	dielectric	rated voltage	rated capacitance	series no.	status	page
interference suppression	sealed case; axial leads	paper/ PETP film	250 V(r.m.s.)	4,7 to 330 nF	276	D	C104
flyback	sealed case; axial leads	paper/polypropylene	750, 1500, 2000 V(peak)	1,5 to 27 nF	278	D	C105
general purposes	lacquered; axial leads	PETP film	160, 400 V(d.c.)	0,001 to 1 μF	311	M	C106
high currents and/or steep pulses	lacquered; radial leads	PETP film	100, 250 400, 630 V(d.c.)	0,001 to 1 μF	347	D	C107
deflection	lacquered; radial leads	polypropylene film	250 V(d.c.)	0,039 to 0,68 μF	357 4	N	C108
deflection	potted; radial leads	polypropylene film	250 V(d.c.)	0,039 to 0,82 μF	357 5	N	C109
deflection	series construction; radial leads	polypropylene/ metallized polypropylene film	630, 1000 1500 V(d.c.)	0,022 to 0,33 μF	357 6 7 8	N	C110
tuned circuits; filter networks	sleeved; axial leads	polystyrene film	63, 160, 250 630 V(d.c.)	51 to 39 000 pF	424 to 431	D	C112-C113
LC filters	potted; radial leads	polystyrene film	63 V(d.c.)	100 to 34 000 pF	443	D	C111
tuned circuits; filter networks	wrapped end-filled; axial leads	polystyrene film	63, 160, 250 630 V(d.c.)	6,2 to 162 nF	444 to 447	N	C114

film capacitors

metallized film

2222 328



These capacitors are used for power factor correction in discharge lighting applications, such as fluorescent mercury and sodium vapour discharge lamp circuits. They are VDE, CEBEC, KEMA, DEMKO and SEMKO approved.

Rated capacitance range, C_R	3 to 22,5 μF
tolerance	± 10%
Rated voltage range, U_R (a.c.)	250 V
Operating frequency	50 to 60 Hz
Category temperature range	−25 to +85 °C
Test voltage between terminals	1,5 x U_R (a.c.) for 10 s
Interconnected terminals and case	2500 V (r.m.s.)
Insulation resistance between:	
terminals	RC > 10 000 s
interconnected terminals and case	R > 12 500 MΩ
Tan δ at 50 Hz $C_R \leqslant 10$ μF	$\leqslant 5 \times 10^{-4}$
$C_R > 10$ μF	$\leqslant 10 \times 10^{-4}$
Dielectric	metallized polypropylene
Climatic category IEC 68	25/085/56

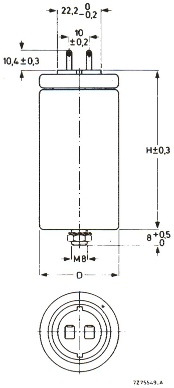


Fig.1a

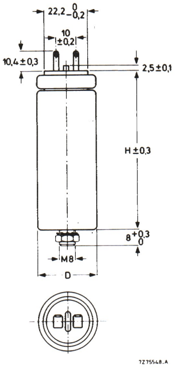
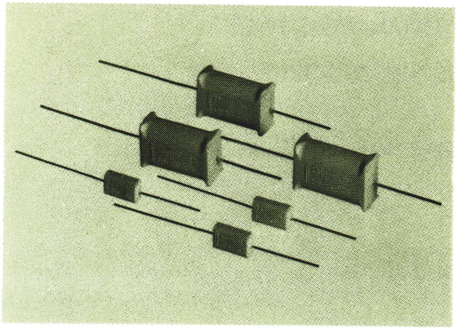


Fig.1b

rated capacitance C_R μF	D	H	fig.	mass approx. g	catalogue number of capacitors	
					without stud	with stud
3	30	63,5	1a	35		2222 328 90016
3,5	30	63,5	1a	38	2222 328 51355	55355
4	30	63,5	1a	40	51405	55405
4,2	30	63,5	1a	41	51425	55425
4,5	30	63,5	1a	43	51455	55455
5	30	63,5	1a	45	51505	55505
5,1	35	63,5	1b	47	90014	
5,5	30	78	1a	47	51555	55555
6	30	78	1a	49	51605	55605
6,5	30	78	1a	51	51655	55655
6,9	35	63,5	1b	63	90015	
7	30	78	1a	53	51705	55705
7	35	63,5	1b	64	90011	90005
8	35	78	1b	67	51805	55805
8	40	63,5	1b	67	90001	90003
9	35	78	1b	70	51905	55905
10	35	78	1b	74	51106	55106
10	40	63,5	1b	71	90002	90004
12	40	78	1b	85	51126	55126
12,5	40	78	1b	89	90007	90006
14	40	78	1b	92	51146	55146
16	40	95	1b	100	51166	55166
18	40	95	1b	108	51186	55186
20	40	107	1b	114	51206	55206
22,5	40	107	1b	123	90009	90008

2222 341 (mepolesco)



Coupling and decoupling capacitors in an axial version for use in general industrial and other professional applications where severe environmental conditions are encountered.

Rated capacitance range, C_R	0,001 to 6,8 μF
tolerance	5, 10 and 20%
Capacitance series	E6 (E12 on request)
Rated voltage range, U_R (d.c.)	100 to 1600 V
U_R (a.c.) 50–60 Hz	63 to 250 V
Category temperature range	−55 to +100 °C
Test voltage (d.c.)	1,6 x U_R
Insulation resistance	
$C \leqslant 0{,}33\ \mu F$; $U_R \geqslant 250$ V (d.c.)	$R > 30\,000\ M\Omega$
$U_R = 100$ V (d.c.)	$R > 15\,000\ M\Omega$
$C > 0{,}33\ \mu F$; $U_R \geqslant 250$ V (d.c.)	$RC > 10\,000$ s
$U_R = 100$ V (d.c.)	$RC > 5000$ s
Tan δ at 10 kHz	
dielectric: polycarbonate	$\leqslant 75 \times 10^{-4}$
PETP	$\leqslant 150 \times 10^{-4}$
Climatic category IEC 68	55/100/56

Composition of the catalogue no.

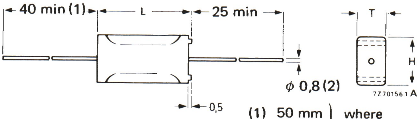
2222 341 . . . . .

dielectric	V (d.c.)	5%	10%	20%
polycarbonate	100	23	29	28
	250	47	49	48
	400	57	59	58
	630	62	61	60
	1000		71	70
	1600		81	80
PETP	100	25	27	26
	250	87	89	88
	400	53	55	54

capacitance code in table

Max steepness (pulse loads)

U_R (d.c.)	L = 14,5	18	23,5	31	mm
100 V	10	7	4	3	V/μs
250 V	20	10	7	5	V/μs
400 V	30	20	10	8	V/μs
630 V	45	30	15	10	V/μs
1000 V	–	45	30	20	V/μs
1600 V	200	90	50	30	V/μs



(1) 50 mm
(2) 1 mm } where L = 31 mm

Selection chart for C_R–U_R and relevant sizes

C_R μF	cap. code	U_R (V) 100 (d.c.) 63 (a.c.) T x L x H	250 160 T x L x H	400 220 T x L x H	630 220 T x L x H	1000 250 T x L x H	1600 250 T x L x H
0,001	102						5,5 x 14,5 x 9,4
0,0015	152						6,5 x 14,5 x 10,4
0,0022	222						6,5 x 18 x 10,4
0,0033	332						6,5 x 18 x 10,4
0,0047	472						7,6 x 18 x 11,5
0,0068	682						7,4 x 23,5 x 11,5
0,01	103			4,7 x 14,5 x 8,7	4,7 x 14,5 x 8,7	6,5 x 18 x 10,4	7,4 x 23,5 x 11,5
0,0015	153			4,7 x 14,5 x 8,7	5,5 x 14,5 x 9,4	7,6 x 18 x 11,5	8,7 x 23,5 x 12,8
0,0022	223			4,7 x 14,5 x 8,7	6,5 x 14,5 x 10,4	7,4 x 23,5 x 11,5	10,4 x 23,5 x 14,4
0,0033	333			4,7 x 14,5 x 8,7	6,5 x 18 x 10,4	8,7 x 23,5 x 12,8	10,4 x 31 x 14,6
0,047	473		4,7 x 14,5 x 8,7	6,5 x 14,5 x 10,4	7,6 x 18 x 11,5	10,4 x 23,5 x 14,4	12,4 x 31 x 19,5
0,068	683		4,7 x 14,5 x 8,7	6,5 x 18 x 10,4	7,4 x 23,5 x 11,5	10,4 x 31 x 14,6	15 x 31 x 22
0,1	104	4,7 x 14,5 x 8,7	5,5 x 14,5 x 9,4	7,6 x 18 x 11,5	8,7 x 23,5 x 12,8	12,4 x 31 x 19,5	
0,15	154	4,7 x 14,5 x 8,7	6,5 x 18 x 10,4	7,4 x 23,5 x 11,5	10,4 x 23,5 x 14,4	15 x 31 x 22	
0,22	224	6,5 x 14,5 x 10,4	7,6 x 18 x 11,5	8,7 x 23,5 x 12,8	10,4 x 31 x 14,6		
0,33	334	6,5 x 18 x 10,4	7,4 x 23,5 x 11,5	10,4 x 23,5 x 14,4	12,4 x 31 x 19,5		
0,47	474	7,6 x 18 x 11,5	8,7 x 23,5 x 12,8	10,4 x 31 x 14,6	15 x 31 x 22		
0,68	684	7,4 x 23,5 x 11,5	10,4 x 23,5 x 14,4	12,4 x 31 x 19,5			
1	105	8,7 x 23,5 x 12,8	10,4 x 31 x 14,6	15 x 31 x 22			
1,5	155	10,4 x 23,5 x 14,4	12,4 x 31 x 19,5				
2,2	225	10,4 x 31 x 14,6	15 x 31 x 22				
3,3	335	12,4 x 31 x 19,5					
4,7	475	15 x 31 x 22					
6,8	685	15 x 31 x 22					

film capacitors

metallized film

2222 344 (nugget)

Coupling and decoupling capacitors of well-defined shape with radial leads. For use in general industrial and professional applications where environmental conditions are of prime importance.

Rated capacitance range, C_R	0,01 to 10 µF
tolerance	5, 10 and 20%
Capacitance series	E6 (E12 on request)
Rated voltage range, U_R (d.c.)	63 to 630 V
U_R (a.c.) 50–60 Hz	40 to 220 V
Category temperature range	–55 to +100 °C
Test voltage	1,6 x U_R
Insulation resistance	
$C \leq 0{,}33$ µF: $U_R \geq 250$ V(d.c.)	R > 30 000 MΩ
$U_R \leq 100$ V(d.c.)	R > 15 000 MΩ
$C > 0{,}33$ µF; $U_R \geq 250$ V(d.c.)	RC > 10 000 s
$U_R \leq 100$ V(d.c.)	RC > 5 000 s
Tan δ at 10 kHz	
dielectric: polycarbonate	$\leq 75 \times 10^{-4}$
PETP	$\leq 150 \times 10^{-4}$
Climatic category IEC 68	55/100/56

Composition of the catalogue no.

2222 344 . . . .

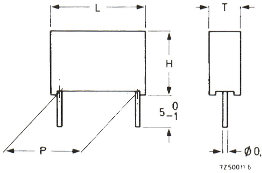
dielectric	V(d.c.)	5%	10%	20%
polycarbonate	100	22	21	20
	250	43	45	44
	400	52	51	50
	630	62	61	60
PETP	63		15	14
	100	23	25	24
	250	42	41	40
	400	53	55	54

capacitance code in table

Max steepness in V/µs (pulse loads)

U_R(d.c.) V	L = 13	L = 17,5	L = 26	L = 30 mm
63	8	4	2	2
100	10	7	3,5	3
250	20	10	6	5
400	30	20	9	8
630	45	30	13	10

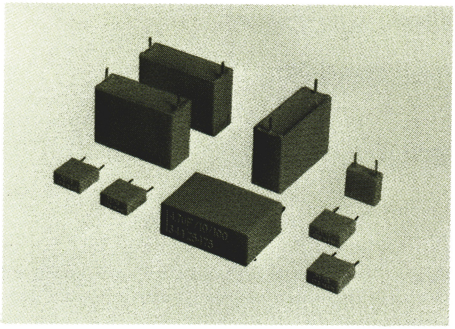
L	P
13	10
17,5	15
26	22,5
30	27,5



Selection chart for C_R–U_R and relevant sizes

		U_R (V)				
		63(d.c.)	100	250	400	630
		40(a.c.)	63	160	200	220
C_R µF	cap. code	T x L x H	T x L x H	T x L x H	T x L x H	T x L x H
0,01	103				4,5 x 13 x 10	4,5 x 13 x 10
0,015	153				4,5 x 13 x 10	5 x 13 x 11
0,022	223				4,5 x 13 x 10	6 x 13 x 12
0,033	333				4,5 x 13 x 10	6 x 17,5 x 11,5
0,047	473			4,5 x 13 x 10	5 x 17,5 x 11	7 x 17,5 x 13
0,068	683			4,5 x 13 x 10	6 x 17,5 x 11,5	8,5 x 17,5 x 14,5
0,1	104		4,5 x 13 x 10	5 x 17,5 x 11	7 x 17,5 x 13	6,5 x 26 x 15,5
0,15	154		4,5 x 13 x 10	6 x 17,5 x 11,5	8,5 x 17,5 x 14,5	7,5 x 26 x 16,5
0,22	224	4,5 x 13 x 10	5 x 13 x 11	7 x 17,5 x 13	6,5 x 26 x 15,5	9 x 26 x 19
0,33	334	5 x 13 x 11	5 x 17,5 x 11	8,5 x 17,5 x 14,5	7,5 x 26 x 16,5	11 x 30 x 20,5
0,47	474	6 x 13 x 12	6 x 17,5 x 11,5	6,5 x 26 x 15,5	9,5 x 26 x 19	13,5 x 30 x 23
0,68	684	6 x 17,5 x 11,5	7 x 17,5 x 13	7,5 x 26 x 16,5	11 x 30 x 20,5	
1	105	7 x 17,5 x 13	8,5 x 17,5 x 14,5	9,5 x 26 x 19	13,5 x 30 x 23	
1,5	155	8,5 x 17,5 x 14,5	6,5 x 26 x 15,5	11 x 30 x 20,5		
2,2	225	6,5 x 26 x 15,5	8,5 x 26 x 18	13,5 x 30 x 23		
3,3	335	8,5 x 26 x 18	9,5 x 26 x 19			
4,7	475	9,5 x 26 x 19	11 x 30 x 20,5			
6,8	685	11 x 30 x 20,5	13,5 x 30 x 23			
10	106	13,5 x 30 x 23				

2222 344 (nugget)
miniature



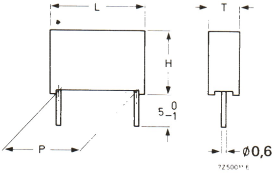
Rated capacitance range, C_R	3,9 to 150 nF
tolerance	5, 10 and 20%
Capacitance series	E6 (E12 on request)
Rated voltage range, U_R (d.c.)	63 to 630 V
U_R (a.c.) 50-60 Hz	40 to 220 V
Category temperature range	−55 to +100 °C
Test voltage	1,6 x U_R
Insulation resistance	
$C \leqslant 0{,}33\ \mu F$: $U_R \geqslant 250$ V (d.c.)	R > 30 000 MΩ
$U_R \leqslant 100$ V (d.c.)	R > 15 000 MΩ
Tan δ at 10 kHz	
dielectric: PETP	$\leqslant 150 \times 10^{-4}$
Climatic category IEC 68	55/100/56

version U_R (d.c.) V	max pulse steepness V/µs
63	10
100	10
250	25
400	40
630	60

Composition of the catalogue no.

2222 344 . . . . .

dielectric	V (d.c.)	%		
PETP	63	20	16	capacitance code in table
		10	17	
	100	20	26	
		10	27	
	250	20	46	
		10	47	
	400	20	56	
		10	57	
	630	20	66	
		10	67	



fixed volume for **ALL types**
T x L x H = 4,5 x 10,5 x 10 mm
P = 7,5 mm

C_R µF	cap. code	U_R (V) 63 (d.c.) 40 (a.c.)	 100 63	 250 160	 400 200	 630 220
0,0047	472					●
0,00681	682					●
0,010	103				●	
0,015	253				●	
0,022	223			●		
0,033	333			●		
0,047	473		●			
0,068	683		●			
0,100	104		●			
0,150	154	●				

film capacitors

metallized film

2222 352 (f.f.c.)

Coupling and decoupling capacitors, colour coded and in a radial lead version: for use in general purpose applications.

Rated capacitance range, C_R	0,001 to 6,8 µF
tolerance	10 and 20%
Capacitance series	E12
Rated voltage range, U_R (d.c.)	100 to 630 V
U_R (a.c.) 50–60 Hz	63 to 220 V
Test voltage between terminals	1,6 x U_R
Category temperature range	–40 to +100 °C
Tan δ at 10 kHz	$\leqslant 150 \times 10^{-4}$
Insulation resistance C ≤ 0,33 µF	R > 30 000 MΩ *
at 20 °C C > 0,33 µF	RC > 10 000 s * (MΩ x µF)
Climatic category IEC 68	**40/100/21**

* Except 100 V version: R > 15 000 MΩ
RC > 5 000 s.

Composition of the catalogue no.

2222 352 .. ..

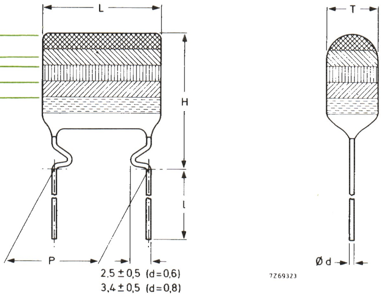
dielectric	U_R	%	long leads	short leads	capacitance code in table
PETP	100	20	24	27	
		10	25	28	
	250	20	44	47	
		10	45	48	
	400	20	54	57	
		10	55	58	
	630	20	64	67	
		10	65	68	

Max steepness in V/µs (pulse load)

U_R V(d.c.)	dimension L (mm) 12,5	17,5	22,5	30
100	10	7	4	3
250	20	10	7	5
400	30	20	10	8
630	45	30	15	10

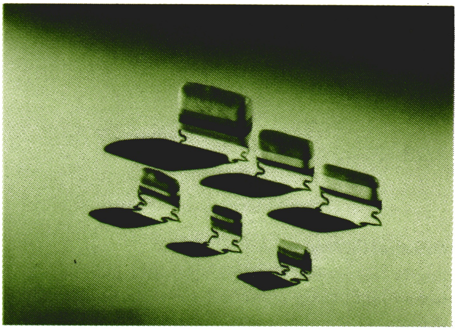
Dimensions (mm)

L	d	P	long leads l	short leads l
12,5	0,6	10,16 ± 0,3	17 ± 4	5–1
17,5	0,8	15,24 ± 0,3	17 ± 4	5–1
22,5	0,8	20,32 ± 0,3	25 ± 4	5–1
30	0,8	27,94 ± 0,3	23 ± 4	5–1



	first two digits of cap. value in pF	multiplier	tolerance	rated voltage
black	0	1	20%	
brown	1	10		100
red	2	10^2		250
orange	3	10^3		
yellow	4	10^4		400
green	5	10^5		
blue	6			630
violet	7			
grey	8			
white	9		10%	

Note: Version with long straight leads available on request (2222 342 series).



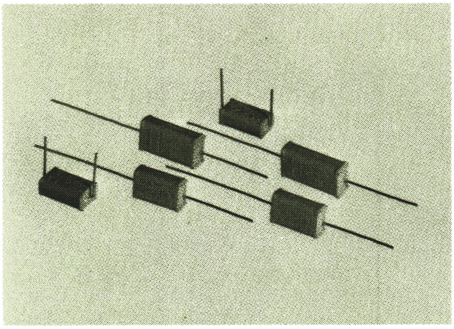
Selection chart for C_R—U_R and relevant sizes

		U_R (V)			
C_R	cap.	100 (d.c.)	250	400	630
		63 (a.c.)	160	220	220
µF	code	T x L x H	T x L x H	T x L x H	T x L x H
0,001	102		4,5 x 12,5 x 12,5		
0,0012	122				
0,0015	152				
0,0018	182				
0,0022	222				
0,0027	272				
0,0033	332				
0,0039	392				
0,0047	472				
0,0056	562				
0,0068	682				
0,0082	822				
0,01	103		4 x 12,5 x 12	4,5 x 12,5 x 12,5	4,5 x 12,5 x 12,5
0,012	123				5 x 12,5 x 13
0,015	153				5,5 x 12,5 x 13,5
0,018	183				6 x 12,5 x 14
0,022	223				6,5 x 12,5 x 14,5
0,027	273			5 x 12,5 x 13	5,5 x 17,5 x 14,5
0,033	333			5,5 x 12,5 x 13,5	6 x 17,5 x 15
0,039	393			6 x 12,5 x 14	6,5 x 17,5 x 15,5
0,047	473	4,5 x 12,5 x 12,5		6,5 x 12,5 x 14,5	7 x 17,5 x 16
0,056	563		4,5 x 12,5 x 12,5	5,5 x 17,5 x 14,5	6 x 22,5 x 15
0,068	683			6 x 17,5 x 15	6,5 x 22,5 x 15,5
0,082	823			6,5 x 17,5 x 15,5	7 x 22,5 x 16
0,1	104		5 x 12,5 x 13	7 x 17,5 x 16	7,5 x 22,5 x 16,5
0,12	124		5,5 x 17,5 x 14,5	6 x 22,5 x 15	8,5 x 22,5 x 17,5
0,15	154	5 x 12,5 x 13	6 x 17,5 x 15	6,5 x 22,5 x 15,5	9,5 x 22,5 x 18,5
0,18	184	5,5 x 12,5 x 13,5	6,5 x 17,5 x 15,5	7 x 22,5 x 16	8,5 x 30 x 17,5
0,22	224	6 x 12,5 x 14	7 x 17,5 x 16	7,5 x 22,5 x 16,5	9,5 x 30 x 18,5
0,27	274	6,5 x 12,5 x 14,5	6 x 22,5 x 15	8,5 x 22,5 x 17,5	9 x 30 x 21
0,33	334	5,5 x 17,5 x 14,5	6,5 x 22,5 x 15,5	9,5 x 22,5 x 18,5	10 x 30 x 22
0,39	394	6 x 17,5 x 15	7 x 22,5 x 16	8,5 x 30 x 17,5	11 x 30 x 23
0,47	474	6,5 x 17,5 x 15,5	7,5 x 22,5 x 16,5	9,5 x 30 x 18,5	12 x 30 x 24
0,56	564	7 x 17,5 x 16	8 x 22,5 x 17	9 x 30 x 21	
0,68	684	6 x 22,5 x 15	9 x 22,5 x 18	10 x 30 x 22	
0,82	824	6,5 x 22,5 x 15,5	8 x 30 x 17	11 x 30 x 23	
1	105	7 x 22,5 x 16	9 x 30 x 18	12 x 30 x 24	
1,2	125	7,5 x 22,5 x 16,5	8,5 x 30 x 20,5		
1,5	155	8,5 x 22,5 x 17,5	9,5 x 30 x 21,5		
1,8	185	9,5 x 22,5 x 18,5	10,5 x 30 x 22,5		
2,2	225	8,5 x 30 x 17,5	11,5 x 30 x 23,5		
2,7	275	9,5 x 30 x 18,5			
3,3	335	9 x 30 x 21			
3,9	395	10 x 30 x 22			
4,7	475	11,5 x 30 x 23,5			
5,6	565	12,5 x 30 x 24,5			
6,8	685	14 x 30 x 26			

film capacitors

metallized film

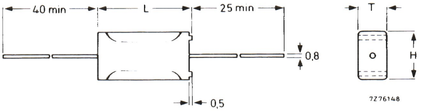
2222 330 (r.i.s.)



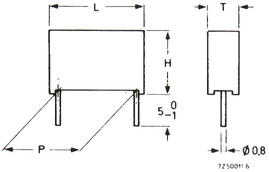
Metallized PETP/paper dielectric

Interference suppression capacitors, dual dielectric, single section type. Designed for radio interference suppression in consumer and general industrial applications (class X).

Rated capacitance range (E6 series), C_R		0,01 to 0,33 µF
tolerance		± 20%
Rated voltage, U_R (a.c.) 50 to 60 Hz		250 V
Test voltage (d.c.)		750 V
Insulation resistance		> 15 000 MΩ
Tan δ at 10 kHz		⩽ 130 x 10^{-4}
Rated temperature		85 °C
Climatic category, IEC 68		40/085/21
	DIN 40040	GPF
Approval	both styles	VDE 0560-7, class X
	style 2 only	SEMKO



style 1



style 2

Dimensions (mm)

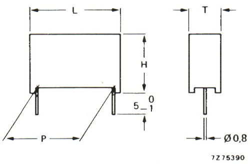
C_R µF	style 1 T x L x H	catalogue no.	style 2 T x L x H	P ± 0,4	catalogue no.
0,01	6,5 x 18 x 10,4	2222 330 00103	5 x 17,5 x 11	15	2222 330 40103
0,015	6,5 x 18 x 10,4	153	5 x 17,5 x 11	15	153
0,022	6,5 x 18 x 10,4	223	5 x 17,5 x 11	15	223
0,033	6,5 x 18 x 10,4	333	5 x 17,5 x 11	15	333
0,047	6,5 x 18 x 10,4	473	6 x 17,5 x 11,5	15	473
0,068	7,6 x 18 x 11,5	683	7 x 17,5 x 13	15	683
0,1	7,4 x 23,5 x 11,5	104	8,5 x 17,5 x 14,5	15	104
0,15	8,7 x 23,5 x 12,8	154	6,5 x 26 x 15,5	22,5	154
0,22	10,4 x 23,5 x 14,4	224	7,5 x 26 x 16,5	22,5	224
0,33			9,5 x 26 x 19	22,5	334

2222 363 (dual dielectric)

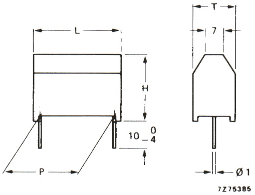
These capacitors are intended for applications where high currents occur. They are mainly used for deflection circuits in television receivers. Thanks to the dual dielectric construction any active flammability under fault conditions is prevented.

Rated capacitance range, C_R	
type with axial leads	0,91 to 1,5 µF
type with radial leads	0,82 to 3,3 µF
Tolerance on rated capacitance	± 5% and ± 10%
Rated voltage U_R (d.c.)	210 V
Rated voltage U_R (a.c.), 50 to 60 Hz	100 V
Rated temperature	85 °C
Test voltage (d.c.) for 1 min between terminals	420 V
Insulation resistance 23 °C	RC > 10 000 s
85 °C	RC > 100 s
Tan δ at 10 kHz	
for C ⩽ 1 µF	$\leqslant 55 \times 10^{-4}$
for C > 1 µF	$\leqslant 75 \times 10^{-4}$
Climatic category IEC 68	40/085/56

Type with radial leads

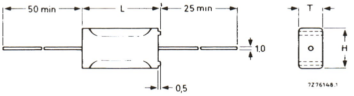


style 1



style 2

Type with axial leads



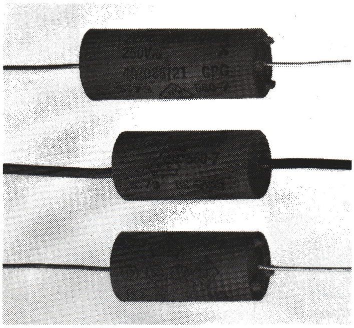
style 3

	C_R µF	T_{max} mm	L_{max} mm	H_{max} mm	P mm	mass g	catalogue no. 2222 363 ..... tol. ± 5%	tol. ± 10%
style 1	0,82	12	34	22	27,5 ± 0,4	10	42824	41824
	1,0						42105	41105
	1,2	15	34	25		15	42125	41125
	1,5						42155	41155
style 2	1,8	17	32	27,5	27,5 ± 0,4	17	42185	41185
	2,2						42225	41225
	2,7	21	32	31,5		23	42275	41275
	3,3						42335	41335
style 3	0,91	12,4	31	19,5		8,5	46914	
	1,0						46105	45105
	1,2	15	31	22		11,7		45125
	1,5							45155

film capacitors

film/foil

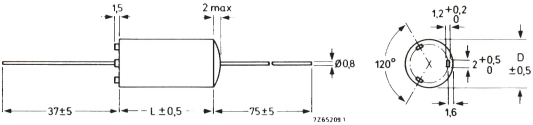
2222 276 (r.i.s.)



Paper/PETP dielectric

Interference suppression capacitors for use in consumer and industrial applications (class X and Y).

Rated capacitance range (E6 series), C_R	4,7 to 330 nF
tolerance	± 20%
Rated voltage, U_R (a.c.)	250 V
Insulation resistance:	
between leads	> 6000 MΩ
between leads and metal foil wrapped around the case	> 6000 MΩ
Tan δ at 1 kHz	$\leqslant 60 \times 10^{-4}$
Climatic category, IEC 68	40/085/21
DIN 40040	GPG (class X) GPF (class Y)
Approval	DEMKO and VDE 0560-7 (class X and Y)



C_R nF	catalogue no.	case size D x L	class (IEC 161) (VDE 0560-7)
6,8	2222 276 60002	13 x 25	Y
10	60003	13 x 25	Y
10	10003	13 x 25	X
15	10004	13 x 25	X
22	10005	13 x 25	X
33	10006	13 x 25	X
47	10007	13 x 25	X
68	10008	13 x 25	X
100	10009	13 x 31	X
150	10011	16 x 36	X
220 *	10012	18 x 36	X
330 *	10013	20 x 41	X
safety capacitor			
4,7	2222 276 60101	13 x 31	Y

* Not VDE approved.

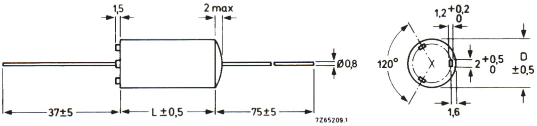
The safety capacitor is approved by:
ASEV (1016)
DEMKO (IEC 65, CEE1 and DHCR21)
NEMKO (IEC 65 and NEMKO 132.56)
SEMKO (IEC 65, CEE1 and SEMKO 101)
VDE (IEC 161, VDE 0560-7 and 0560-2)

2222 278

Paper/polypropylene dielectric

A series of dual dielectric capacitors specifically designed for use in tv line flyback circuits.

Rated capacitance range, C_R	1,5 to 27 nF
tolerance	5%
Peak voltage C = 10-27 nF	⩽ 750 V
C = 1,5-12 nF	⩽ 1500 V
C = 1,5-10 nF	⩽ 2000 V
Pulse duration	10 to 14 μs
Pulse steepness	⩽ 750 V/μs
Category temperature range	−25 to +70 °C



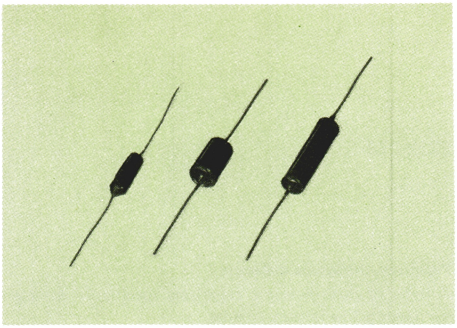
C_R nF	peak voltage V	case size L x D	catalogue no.
10	750	25 x 13	2222 278 52103
11		25 x 13	52113
12		25 x 13	52123
13		25 x 13	52133
15		25 x 13	52153
16		25 x 13	52163
18		31 x 13	52183
20		31 x 13	52203
22		31 x 13	52223
24		31 x 13	52243
27		31 x 13	52273
1,5	1500	31 x 13	72152
1,6		31 x 13	72162
1,8		31 x 13	72182
2		31 x 13	72202
2,2		31 x 13	72222
2,4		31 x 13	72242
2,7		31 x 13	72272
3		31 x 13	72302
3,3		31 x 13	72332
3,6		31 x 13	72362
3,9		36 x 16	72392
4,3		36 x 16	72432
4,7		36 x 16	72472
5,1		36 x 16	72512
5,6		36 x 16	72562
6,2		36 x 16	72622
6,8		36 x 16	72682
7,5		36 x 16	72752
8,2		36 x 16	72822
9,1		36 x 16	72912
10		36 x 16	72103
11		36 x 18	72113
12		36 x 18	72123

C_R nF	peak voltage V	case size L x D	catalogue no.
1,5	2000	31 x 13	2222 278 82152
1,6		31 x 13	82162
1,8		31 x 13	82182
2		31 x 13	82202
2,2		31 x 13	82222
2,4		31 x 13	82242
2,7		31 x 13	82272
3		31 x 13	82302
3,3		31 x 13	82332
3,6		31 x 13	82362
3,9		36 x 16	82392
4,3		36 x 16	82432
4,7		36 x 16	82472
5,1		36 x 16	82512
5,6		36 x 16	82562
6,2		36 x 16	82622
6,8		36 x 16	82682
7,5		36 x 16	82752
8,2		36 x 16	82822
9,1		36 x 16	82912
10		36 x 16	82103

film capacitors

film/foil

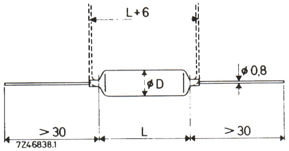
2222 311



PETP dielectric

Due to its construction this capacitor is very suitable for applications where high pulse steepness occurs.

Rated capacitance range, C_R	1 to 1000 nF
tolerance	10%
Capacitance series	E6
on request	E12
Rated voltage range, U_R (d.c.)	160 and 400 V
U_R (a.c.) 50—60 Hz	90 and 150 V
Test voltage	2 x U_R
Category temperature range	—40 to +85 °C
Tan δ at 1 kHz	$< 60 \times 10^{-4}$
Insulation resistance at 20 °C	
C ⩽ 0,33 μF	R > 50 000 MΩ
C > 0,33 μF	RC > 16 500 s



Composition of the catalogue no.

2222 311 . . . . .

160 V version 31 — capacitance code in table

400 V version 51

Selection chart for C_R—U_R and relevant sizes

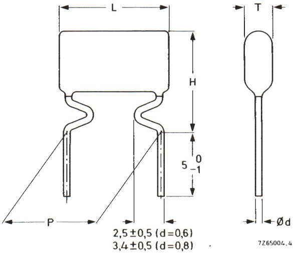
		U_R (V)	
		d.c. 160	400
		a.c. 90	150
C_R nF	cap. code	D x L	D x L
1	102		7,5 x 18
1,5	152		7,5 x 18
2,2	222		7,5 x 18
3,3	332		7,5 x 18
4,7	472		7,5 x 18
6,8	682		7,5 x 18
10	103	7,5 x 18	7,5 x 18
15	153	7,5 x 18	7,5 x 18
22	223	7,5 x 18	8,5 x 18
33	333	7,5 x 18	10 x 18
47	473	8 x 18	11,5 x 18
68	683	9 x 18	9,5 x 32
100	104	10,5 x 18	11 x 32
150	154	12 x 18	12,5 x 32
220	224	10 x 32	14,5 x 32
330	334	12 x 32	17 x 32
470	474	14 x 32	19,5 x 32
680	684	16 x 32	
1000	105	18,5 x 32	

2222 347 (p.p.c.)

PETP dielectric

A radial lead, lacquer-encapsulated capacitor for coupling and decoupling where steep pulses are encountered.

Rated capacitance range, C_R	1 to 1000 nF
tolerance	10 and 20%
Capacitance series	E6
on request	E12
Rated voltage range, U_R (d.c.)	100 to 630 V
U_R (a.c.) 50–60 Hz	50 to 200 V
Test voltage	2 x U_R
Category temperature range	–40 to +100 °C
Tan δ at 10 kHz	$< 110 \times 10^{-4}$
Insulation resistance $C \leqslant 330$ nF	$R > 50\,000$ MΩ
at 20 °C $C > 330$ nF	$RC > 16\,500$ s
Climatic category, IEC 68	**40/100/21**
Pulse steepness	limited by circuit



L	P	d
13,5	10,16 (4e)	0,6
19	15,24 (6e)	0,8
27	22,86 (9e)	0,8
32	27,94 (11e)	0,8

Composition of the catalogue no.

2222 347 . . . . .

capacitance code in table

U_R	%	
100	20	20
	10	21
250	20	40
	10	41
400	20	50
	10	51
630	20	60
	10	61

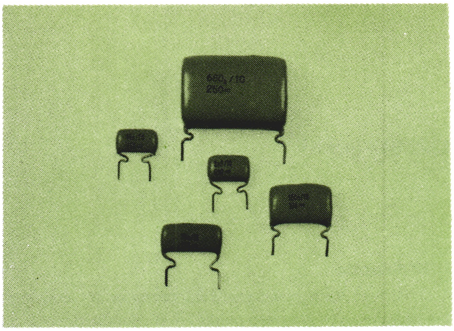
Selection chart for C_R–U_R and relevant sizes

		U_R (V)			
		100 d.c.	250	400	630
C_R	cap.	50 a.c.	80	125	200
nF	code	T x L x H	T x L x H	T x L x H	T x L x H
1,0	102				5,5 x 13,5 x 13
1,5	152				5,5 x 13,5 x 13
2,2	222				4,5 x 13,5 x 12
3,3	332				5,5 x 13,5 x 13
4,7	472			4,5 x 13,5 x 12	6 x 13,5 x 13
6,8	682			5,5 x 13,5 x 13	7 x 13,5 x 14,5
10	103		5 x 13,5 x 12,5	6 x 13,5 x 13,5	6 x 19 x 14,5
15	153	4,5 x 13,5 x 12	5,5 x 13,5 x 13	7 x 13,5 x 14,5	7 x 19 x 15,5
22	223	5,5 x 13,5 x 13	6,5 x 13,5 x 14	6 x 19 x 14,5	8 x 19 x 16,5
33	333	6 x 13,5 x 13,5	5,5 x 19 x 14	7 x 19 x 15,5	7 x 27 x 18,5
47	473	7 x 13,5 x 14,5	6,5 x 19 x 15	8 x 19 x 16,5	8,5 x 27 x 20
68	683	6 x 19 x 14,5	7,5 x 19 x 16	7 x 27 x 18,5	10,5 x 27 x 22
100	104	7 x 19 x 15,5	6,5 x 27 x 18	8,5 x 27 x 20	11 x 32 x 22,5
150	154	8 x 19 x 16,5	8 x 27 x 19,5	10,5 x 27 x 22	13,5 x 32 x 25
220	224	7 x 27 x 18,5	9,5 x 27 x 21	11 x 32 x 22,5	
330	334	8,5 x 27 x 20	10 x 32 x 21,5	13,5 x 32 x 25	
470	474	10,5 x 27 x 22	12 x 32 x 23,5		
680	684	11 x 32 x 22,5	15 x 32 x 26,5		
1000	105	13,5 x 32 x 25			

film capacitors

film/foil

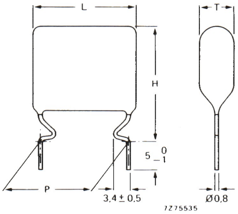
2222 357 4



Polypropylene dielectric, lacquered type

These capacitors are intended for applications where high currents and steep pulses occur, e.g. in deflection units in tv receivers.

Rated capacitance range (E12 series), C_R		0,039 to 0,68 μF	
tolerance		± 5 and ± 10%	
Rated voltage range, U_R	(d.c.)	250 V	
	(a.c.) 50 to 60 Hz	80 V	
Test voltage (d.c.)		2 x U_R	
Rated temperature		85 °C	
	T_{amb}	23 °C	85 °C
Insulation resistance,	C ⩽ 0,1 μF	R > 50 000 MΩ	> 500 MΩ
	C > 0,1 μF	RC > 5000 s	> 50 s
Tan δ at 10 kHz		⩽ 10 x 10^{-4} (typ 2 x 10^{-4})	
Climatic category, IEC 68		40/085/21	
Pulse steepness		limited by circuit	



L	P ± 0,3
19,5	15,24
27	22,86
32	27,94

Composition of the catalogue no.

2222 357 4 . . . .

tolerance
8 = ± 10%
9 = ± 5%

capacitance code in table

Selection chart for C_R—U_R and relevant sizes

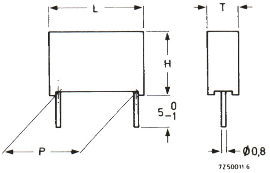
C_R μF	U_R = 250 V (d.c.) 80 V (a.c.) T x L x H	cap. code
0,039	6 x 19,5 x 14,5	393
0,047	6,5 x 19,5 x 15	473
0,056	7,5 x 19,5 x 16	563
0,068	8 x 19,5 x 16,5	683
0,082	9 x 19,5 x 17,5	823
0,10	6 x 27 x 17,5	104
0,12	7 x 27 x 18,5	124
0,15	7,5 x 27 x 19	154
0,18	8,5 x 27 x 20	184
0,22	8 x 32 x 19,5	224
0,27	9 x 32 x 20,5	274
0,33	10 x 32 x 21,5	334
0,39	11 x 32 x 22,5	394
0,47	12,5 x 32 x 24	474
0,56	14 x 32 x 25,5	564
0,68	15,5 x 32 x 27	684

2222 357 5

Polypropylene dielectric, potted type

These capacitors are intended for applications where high currents and steep pulses occur, e.g. in deflection units in tv receivers.

Rated capacitance range (E12 series), C_R	0,039 to 0,82 µF	
tolerance	± 5 and ± 10%	
Rated voltage range, U_R (d.c.)	250 V	
(a.c.) 50 to 60 Hz	160 V	
Test voltage (d.c.)	2 x U_R	
Rated temperature	25 °C	
T_{amb}	23 °C	85 °C
Insulation resistance, $C \leqslant 0,1$ µF	$R > 50\,000$ MΩ	> 500 MΩ
$C > 0,1$ µF	$RC > 5000$ s	> 50 s
Tan δ at 10 kHz	$\leqslant 5 \times 10^{-4}$ (typ 1×10^{-4})	
Climatic category, IEC 68	40/085/56	
Pulse steepness	limited by circuit	



L	P ± 0,4
21,5	15,0
29	22,5
34	27,5

Composition of the catalogue no.

2222 357 5 . . . .

tolerance
1 = ± 10%
2 = ± 5%

capacitance code in table

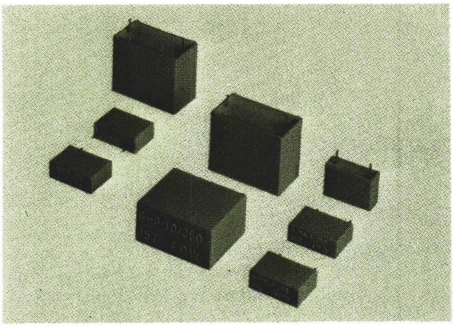
Selection chart for C_R–U_R and relevant sizes

C_R µF	d.c. 250 a.c. 160 T x L x H	cap. code
0,039	8 x 21,5 x 15	393
0,047	8 x 21,5 x 15	473
0,056	8 x 21,5 x 15	563
0,068	10 x 21,5 x 17	683
0,082	10 x 21,5 x 17	823
0,10	8,5 x 29 x 18,5	104
0,12	8,5 x 29 x 18,5	124
0,15	8,5 x 29 x 18,5	154
0,18	10 x 29 x 20	184
0,22	10 x 34 x 20	224
0,27	10 x 34 x 20	274
0,33	12 x 34 x 22	334
0,39	12 x 34 x 22	394
0,47	15 x 34 x 25	474
0,56	15 x 34 x 25	564
0,68	18 x 34 x 28	684
0,82	18 x 34 x 28	824

film capacitors

film/foil

2222 357 6
2222 357 7
2222 357 8



Polypropylene/metallized polypropylene, series construction
The construction of this capacitor enables it to withstand high currents, high voltages and steep pulses. It is commonly used in television sets in deflection circuits and a.c. motor control.

Rated capacitance range (E12 series), C_R		0,022 to 0,33 µF	
tolerance		± 5 and ± 10%	
Rated voltage range, U_R	(d.c.)	630, 1000 and 1500 V	
	(a.c.) 50 to 60 Hz	300, 400 and 600 V	
Test voltage (d.c.)		2 x U_R	
Rated temperature		85 °C	
	T_{amb}	23 °C	85 °C
Insulation resistance,	C ⩽ 0,1 µF	R > 50 000 MΩ	> 500 MΩ
	C > 0,1 µF	RC > 5000 s	> 50 s
Tan δ at 100 kHz			
for P = 22,5 mm		⩽ 10×10^{-4}	
for P = 27,5 mm		⩽ 15×10^{-4}	
Climatic category, IEC 68		40/085/56	
Pulse steepness		limited by circuit	

Composition of the catalogue no.

2222 357 . . . . .

capacitance code in table

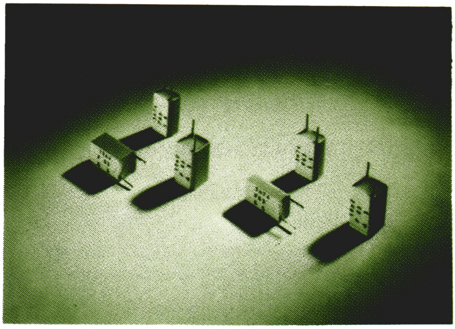
V(d.c.)	5%	10%
630	62	61
1000	72	71
1500	82	81

L	P ± 0,4
29	22,5
34	27,5

Selection chart for C_R—U_R and relevant sizes

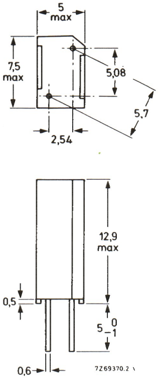
		U_R (V)		
		630 d.c.	1000	1500
C_R	cap.	300 a.c.	400	600
µF	code	T x L x H	T x L x H	T x L x H
0,022	223			8,5 x 29 x 18,5
0,027	273			8,5 x 29 x 18,5
0,033	333		8,5 x 29 x 18,5	10 x 29 x 20
0,039	393		8,5 x 29 x 18,5	10 x 29 x 20
0,047	473	8,5 x 29 x 18,5	10 x 29 x 20	10 x 34 x 20
0,056	563	8,5 x 29 x 18,5	10 x 29 x 20	12 x 34 x 22
0,068	683	10 x 29 x 20	10 x 34 x 20	12 x 34 x 22
0,082	823	10 x 29 x 20	12 x 34 x 22	15 x 34 x 25
0,10	104	10 x 29 x 20	12 x 34 x 22	15 x 34 x 25
0,12	124	10 x 34 x 20	15 x 34 x 25	18 x 34 x 28
0,15	154	12 x 34 x 22	18 x 34 x 28	18 x 34 x 28
0,18	184	12 x 34 x 22	18 x 34 x 28	
0,22	224	15 x 34 x 25	18 x 34 x 28	
0,27	274	18 x 34 x 28		
0,33	334	18 x 34 x 28		

2222 443 (p.f.c.)

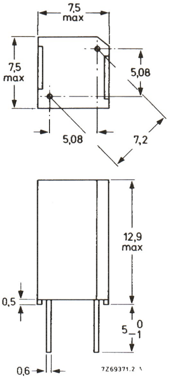


Polystyrene dielectric
Professional LC filters need these very stable and accurate capacitors (as in telephony equipment).
The 443 series, in combination with our ferrites, offer an advantage when it comes to package density.

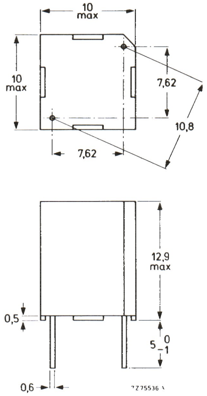
Rated capacitance range (E96 series), C_R	100 to 34 000 pF
tolerance	± 1%
Rated voltage, U_R (d.c.)	63 V
(a.c.) 50 to 60 Hz	25 V
Test voltage	2 x U_R
Category temperature range	−40 to +70 °C
Insulation resistance at 23 °C	> 500 000 MΩ
at 70 °C	> 100 000 MΩ
Tan δ at 1 MHz; $C \leqslant 500$ pF	$\leqslant 5 \times 10^{-4}$
500 pF < C ⩽ 1000 pF	$\leqslant 10 \times 10^{-4}$
at 1 kHz; C > 1000 pF	$\leqslant 2 \times 10^{-4}$
Climatic category IEC 68	40/70/56
Basic specification	IEC 275


5 max
7,5 max
5,08
5,7
2,54
12,9 max
0,5
5 0 −1
0,6
7Z69370.2

Style 1, capacitors of rated capacitance range 100 to 3920 pF


7,5 max
7,5 max
5,08
5,08
7,2
12,9 max
0,5
5 0 −1
0,6
7Z69371.2

Style 2, capacitors of rated capacitance range 100 to 12 100 pF.


10 max
10 max
7,62
10,8
7,62
12,9 max
0,5
5 0 −1
0,6
7Z75536

Style 3, capacitors of rated capacitance > 15 000 pF.

Composition of the catalogue no.

2222 443 . . . . .

4 = style 1; C ⩽ 3920 pF
    or style 2; C > 3920 pF
    or style 3, C > 15 000 pF
8 = style 2; C ⩽ 3920 pF

first three digits of capacitance value in pF

factor: 1 = 1
2 = 10
3 = 100

Example:
Capacitor 1650 pF, style 2, catalogue no. 2222 443 81652.

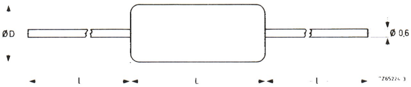
film capacitors

film/foil

2222 424 to 2222 431 (micropoco)

Polystyrene dielectric
Due to their narrow tolerances, high stability, and low losses these axial lead capacitors are very suitable for use in tuned circuits and filters.
Capacitors are also available on reel.

Rated capacitance range, C_R	51 to 39 000 pF
tolerance	5% (E24), 2% (E48) and 1% (E96)
Capacitance series	E24 (E48 and E96 on request)
Rated voltage range, U_R (d.c.)	63 to 630 V
U_R (a.c.) 50–60 Hz	25 to 250 V
Test voltage (d.c.)	2 x U_R
Temperature range 63 V	–40 to +70 °C
125 V to 500 V	–40 to +85 °C
Tan δ at 1 MHz $C \leqslant 1$ nF	$\leqslant 10 \times 10^{-4}$
at 100 kHz $C \leqslant 20$ nF	$\leqslant 5 \times 10^{-4}$
at 10 kHz $C > 20$ nF	$\leqslant 5 \times 10^{-4}$
Insulation resistance at 20 °C	
$C \leqslant 100$ nF	R > 100 000 MΩ
$C > 100$ nF	RC > 10 000 s



L	l_{min}
10,9	28
15	25,5

Selection chart for C_R–U_R and relevant sizes

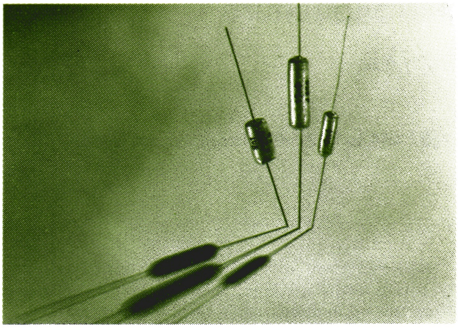
		U_R (V)		
		d.c. 160	250	630
C_R	cap.	a.c. 63	125	250
pF	code	D x L	D x L	D x L
51	5109			3,5 x 10,9
56	5609			3,5
62	6209			3,5
68	6809			3,5
75	7509			3,5
82	8209			3,5
91	9109			3,5
100	1001			3,5
110	1101			3,5
120	1201			3,5
130	1301			3,5
150	1501			3,5
160	1601			3,5
180	1801			3,5
200	2001			3,5
220	2201			3,5
240	2401			3,5
270	2701			3,5
300	3001			3,5
330	3301			3,5
360	3601			3,5
390	3901		3,5 x 10,9	4
430	4301		3,5	4
470	4701		3,5	4
510	5101		3,5	4
560	5601		3,5	4
620	6201		3,5	4,5
680	6801		3,5	4,5
750	7501		3,5	5
820	8201	3,5 x 10,9	4	5
910	9101	3,5	4	5
1000	1002	3,5	4	5
1100	1102	3,5	4,5	5

Composition of the catalogue no.

2222 4 . . . .

capacitance code in table

	U_R		%	
packed in boxes	63	24	5	2
	160	25	2	3
	250	26	1	4
	630	27		
on bandolier and reel	63	28	5	6
	160	29	2	7
	250	30	1	8
	630	31		



Selection chart for C_R–U_R and relevant sizes

		U_R (V)							
		d.c. 63 a.c. 25		160 63		250 125		630 250	
C_R pF	cap. code	D	x L	D	x L	D	x L	D	x L
1 200	1202	3,5	x 10,9	4	x 10,9	4,5	x 10,9	5	x 10,9
1 300	1302	3,5		4		4,5		5	x 15
1 500	1502	3,5		4		4,5		5	
1 600	1602	3,5		4		5		5,5	
1 800	1802	3,5		4,5		5		5,5	
2 000	2002	3,5		4,5		5		5,5	
2 200	2202	3,5		4,5		5		5,5	
2 400	2402	3,5		4,5		5	x 15	5,5	
2 700	2702	4		4,5		5		6	
3 000	3002	4		5		5		6,5	
3 300	3302	4		5		5		6,5	
3 600	3602	4		5		5		7	
3 900	3902	4		5		5		7	
4 300	4302	4,5		5	x 15	5		7,5	
4 700	4702	4,5		5		5,5		8	
5 100	5102	4,5		5		5,5		8	
5 600	5602	4,5		5		6		8	
6 200	6202	5		5		6			
6 800	6802	5		5		6,5			
7 500	7502	5	x 15	5,5		6,5			
8 200	8202	5		6		7			
9 100	9102	5		6		7,5			
10 000	1003	5		6		7,5			
11 000	1103	5,5		6,5		7,5			
12 000	1203	5,5		6,5					
13 000	1303	5,5		6,5					
15 000	1503	5,5		7					
16 000	1603	6		7					
18 000	1803	6							
20 000	2003	6							
22 000	2203	6,5							
24 000	2403	6,5							
27 000	2703	7							
30 000	3003	7							
33 000	3303	7,5							
36 000	3603	7,5							
39 000	3903	8							

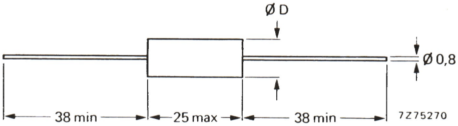
film capacitors

film/foil

2222 444 to 2222 447 (wrapped end-filled)

These polystyrene "wrapped end-filled" types are for use in circuits where precision, reliability and low losses are important e.g. in tuned circuits, filter networks, etc.

Rated capacitance range, C_R (E24-E48 and E96 series)	6,2 to 162 nF
tolerance	± 5% (E24) ± 2% (E48) ± 1% (E96)
Rated voltage range, U_R (d.c.)	63, 160, 250, 630 V
(a.c.) 50 to 60 Hz	25, 63, 125, 250 V
Rated temperature: 63 V	70 °C
125 to 500 V	85 °C
Tan δ at 100 kHz; C ⩽ 20 nF at 10 kHz; C > 20 nF	⩽ 5 x 10^{-4}
Climatic category, IEC 68: 63 V	40/70/56
125 to 500 V	40/85/56
Basic specification	IEC 275 revised version



Composition of the catalogue no.

2222 44 . . . . .

U_R	tolerance on C_R	first three digits of cap. value in nF	factor
4 = 63 V	2 = ± 5%		2 = 0,01
5 = 125 V	3 = ± 2%		3 = 0,1
6 = 250 V	4 = ± 1%		4 = 1
7 = 500 V			

Selection chart for C_R–U_R and relevant sizes

C_R nF	d.c. 63 V a.c. 25 V	D_{max} 160 V 63 V	250 V 125 V	630 V 250 V
6,2				7,5
6,8				7,5
7,5				8
8,2				8
9,1				8,5
10				9
11				9
12			7	9,5
13			7	10
15			7,5	10,5
16			7,5	11
18		6,5	8	11,5
20		7	8,5	12
22		7	8,5	12,5
24		7,5	9	12,5
27		7,5	9,5	
30		8	10	
33		8,5	10,5	
36		8,5	10,5	
39		9	11	
43	7	9,5	11,5	
47	7,5	9,5	12	
51	7,5	10		
56	8	10,5		
62	8,5	11		
68	8,5	11,5		
75	9	12		
82	9,5	12,5		
91	9,5			
100	10			
110	10,5			
120	11			
130	11,5			
150	12			
160	12,5			
162	12,5			

ceramic capacitors

survey

For detailed information
Handbook CM2b

Tuning: type 1
Coupling and decoupling: type 2 and 3

version	type	rated d.c. voltage V	capacitance range pF	series	status	page
general						
miniature plate	1	63 or 100	0,56 – 560	2222 631 to 643	D	C116
	2	100	180 – 4 700	630	D	C117
	2	100	1 000 – 10 000	640	D	C117
	2	63	1 000 – 22 000	629	D	C117
disc	1	400	0,47 – 47	625	D	C118
	2	400	100 – 3 300	627	D	C119
high-voltage						
disc	2	2000	33 – 560	2212 659	D	C120
	2	1000	33 – 820			
interference suppression						
disc	2	250 V(a.c.)	220 – 2 200	2212 660	D	C121
safety						
disc	2	400 V(a.c.)	33 – 1 000	2212 661	D	C121
tube	1B	400 V(a.c.)	22 – 390	2212 619	C	C122
	2	400 V(a.c.)	390 – 4 700	619	C	C122
feed-through	2	350	2,5 – 2 200	2222 700	M	C123
	2	350	2,5 – 4 700	702	M	C123
multilayer						
ceramic chip	1	50	10 – 10 000	2222 851 to 856	D	C124
	2	50	100 – 470 000			

ceramic capacitors

miniature plate

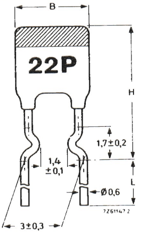
tuning — type 1

2222 631 632 638
2222 641 642 643

Low voltage capacitors for use in h.f. circuits where their excellent electrical properties and small size, compared with mechanical trimmers, offer definite advantages.

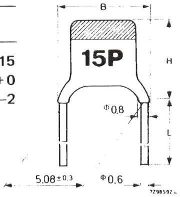
Capacitance range (E12 series)	0,56 to 560 pF
tolerance C < 10 pF	0,25 pF
C ⩾ 10 pF	± 2%
Rated voltage (d.c.)	63 or 100 V
with test voltage (d.c.)	200 or 300 V
Category temperature range	−55 to +85 °C
Insulation resistance	> 10 000 MΩ
Tan δ C < 50 pF	$\leqslant 15(15/C + 0{,}7)10^{-4}$; max 55×10^{-4}
C > 50 pF	$\leqslant 15 \times 10^{-4}$
Climatic category IEC 68	55/085/21
Basic specification	IEC 108, type 1

style	L
643	⩾ 10



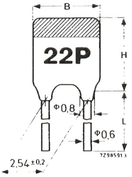
size	B_{max}	x	H_{max}
I	3,5	x	8
II	4,5	x	9
III	5,5	x	10
IV	6,5	x	11
V	6,5	x	14

style	L
638	⩾ 15
642	6^{+0}_{-2}



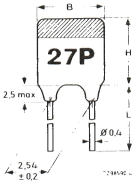
size	B_{max}	x	H_{max}
I	6,5	x	6
II	6,5	x	7
III	6,5	x	8
IV	6,5	x	9
V	6,5	x	12

style	L
631	⩾ 15
641	6^{+0}_{-2}



size	B_{max}	x	H_{max}
I	3,5	x	4,5
II	4,5	x	5,5
III	5,5	x	6,5
IV	6,5	x	7,5
V	6,5	x	10,5

style	L
632	⩾ 15 flexible leads



size	B_{max}	x	H_{max}
I	3,5	x	4,5
II	4,5	x	5,5
III	5,5	x	6,5
IV	6,5	x	7,5
V	6,5	x	10,5

Composition of the catalogue no.

2222 . . . .

style — see drawings

code

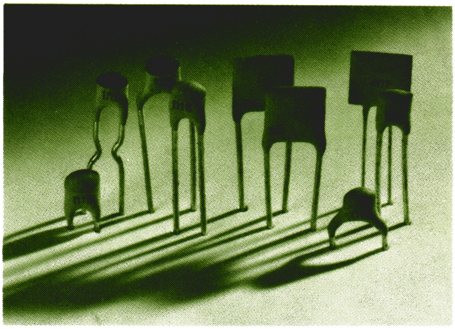
first two digits of capacitance value in pF

factor
7 = 0,01
8 = 0,1
9 = 1
1 = 10

code in cat. no.	capacitance range (E12) and relevant size size I	II	III	IV	V	temperature coefficient ppm/ °C	colour code	rated d.c. voltage V
03	0,56 – 6,8	8,2	–	–	–	+100	red/violet	100
04	–	10 – 15	18 – 22	27 – 33	39 – 47			
09	1,8 – 8,2	–	–	–	–	0	black	100
10	10 – 18	22 – 39	47 – 56	68 – 82	100 – 120			
27	3,9 – 8,2	–	–	–	–	−75	red	63
28	10 – 18	22 – 39	47 – 56	68 – 82	100 – 120			
33	3,9 – 8,2	–	–	–	–	−150	orange	100
34	10 – 22	27 – 47	56 – 68	82 – 100	120 – 150			
39	3,9 – 8,2	–	–	–	–	−220	yellow	63
40	10 – 22	27 – 47	56 – 68	82 – 100	120 – 150			
45	4,7 – 8,2	–	–	–	–	−330	green	100
46	10 – 27	33 – 56	68 – 82	100 – 120	150 – 180			
51	6,8 – 8,2	–	–	–	–	−470	blue	100
52	10 – 33	39 – 68	82 – 100	120 – 150	180 – 220			
57	3,9 – 8,2	–	–	–	–	−750	violet	100
58	10 – 47	56 – 100	120 – 150	180 – 220	270 – 330			
70	18 – 82	100 – 180	220 – 270	330 – 390	470 – 560	−1500	orange/orange	100

coupling and decoupling — type 2
2222 629 630 640

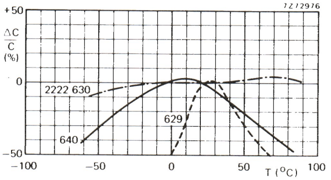
Low voltage capacitors for use in a wide variety of electronic equipment where a non-linear change in capacitance with temperature is acceptable. Their small size is also advantageous. With values up to 22 nF these three styles complement our lower capacitor ranges of type 1 capacitors.



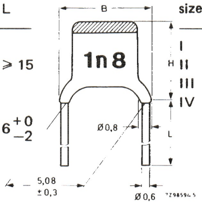
SERIES 2222 . . .	629	630	640	
Capacitance range	1000 to 22 000	180 to 4700	1000 to 10 000	pF pF
tolerance	−20/+80	10	−20/+50	%
Rated voltage (d.c.)	63	100	100	V
Test voltage (d.c.)	200	300	300	V
Category temperature range	−10 to +55	−55 to +85	−55 to +85	°C
Insulation resistance	> 1000	> 1000	> 3000	MΩ
Tan δ at 1 kHz	< 3,5	< 3,5	< 3,5	%
Climatic category IEC 68	10/055/21	55/085/21	55/085/21	
Basic specification	IEC 187	IEC 187	IEC 187	

Available values: refer to relevant drawing

capacitance µF	size 629	630	640	code in catalogue no.
180		I		181
220		I		221
270		I		271
330		I		331
390		I		391
470		I		471
560		I		561
680		I		681
820		I		821
1000	I	II	I	102
1200		II		122
1500		II	I	152
1800		II		182
2200	I	III	I	222
2700		III		272
3300		IV	II	332
3900		IV		392
4700	I	IV	II	472
6800			III	682
10000	II		IV	103
22000	IV			223

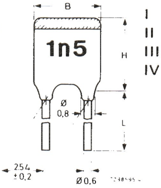


catalogue no.	L
2222 629 03 . . .	
2222 630 03 . . .	≥ 15
2222 640 03 . . .	
2222 629 06 . . .	
2222 630 06 . . .	6 $^{+0}_{-2}$
2222 640 06 . . .	



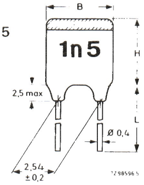
size	Bmax	x	Hmax
I	6,5	x	6
II	6,5	x	7
III	6,5	x	8
IV	6,5	x	9

catalogue no.	L
2222 629 01 . . .	
2222 630 01 . . .	≥ 15
2222 640 01 . . .	
2222 629 05 . . .	
2222 630 05 . . .	6 $^{+0}_{-2}$
2222 640 05 . . .	



size	Bmax	x	Hmax
I	3,5	x	4,5
II	4,5	x	5,5
III	5,5	x	6,5
IV	6,5	x	7,5

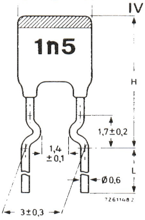
catalogue no.	L
2222 629 02 . . .	
2222 630 02 . . .	≥ 15
2222 640 02 . . .	



size	Bmax	x	Hmax
I	3,5	x	4,5
II	4,5	x	5,5
III	5,5	x	6,5
IV	6,5	x	7,5

catalogue no.	L
2222 629 07 . . .	
2222 630 07 . . .	≥ 10
2222 640 07 . . .	

code



size	Bmax	x	Hmax
I	3,5	x	8
II	4,5	x	9
III	5,5	x	10
IV	6,5	x	11

ceramic capacitors

disc

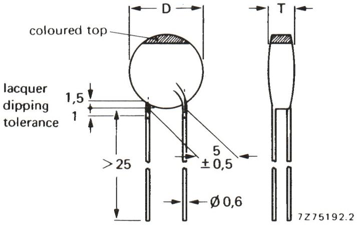
tuning — type 1
2222 625

Low losses, high stability and linear temperature dependence. Ideal for use in h.f. circuits, especially in resonant circuits where their linear temperature characteristics compensate non-linear behaviour in other components.

Capacitance range	0,47 to 47 pF
Tolerance on C ⩽ 2,2 pF	± 0,25 pF
C = 2,7 to 10 pF	± 0,5 pF
C ⩾ 12 pF	± 5%
Rated voltage (d.c.)	400 V
Test voltage (d.c.)	1100 V
Category temperature range	−40 to +85 °C
Insulation resistance	> 10 000 MΩ
Tan δ at 1MHz C < 10 pF	$< \frac{0,01}{C\ (pF)}$
C ⩾ 10 pF	$< 10 \times 10^{-4}$
Climatic category IEC 68	40/085/21

size	D_{max}	T
I	5	3
II	5	3,5
III	5	4
IV	5	4,5
V	5	5
VI	6	3

size	D_{max}	T
VII	6	3,5
VIII	6	4
IX	6	4,5
X	6	5
XI	6	6
XII	8	3

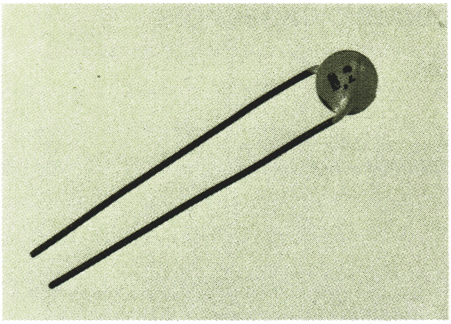


Composition of the catalogue no.

2222 625 . . . . .

For last 5 digits see code in table

capacitance pF	temperature coefficient +100 ppm/°C top: red/violet size	code	0 ppm/°C top: black size	code	−150 ppm/°C top: orange size	code	−750 ppm/°C top: violet size	code
0,47	IV	03477						
0,75	II	03757						
1	VI	03108	X	09108				
1,2	III	03128	IX	09128				
1,5	II	03158	VIII	09158				
1,8	II	03188	II	09188	XI	33188	V	57188
2,2	II	03228	VII	09228	V	33228	IV	57228
2,7	VI	02278	III	08278	IV	32278	III	56278
3,3	VI	02338	II	08338	III	32338	II	56338
3,9	VI	02398	VIII	08398	II	32398	VIII	56398
4,7	XII	02478	VII	08478	I	32478	VII	56478
5,6	XII	02568	VI	08568	VII	32568	VI	56568
6,8	XII	02688	VI	08688	VI	32688	III	56688
8,2	XII	02828	VI	08828	VI	32828	II	56828
10			VI	08109	VI	32109	I	56109
12			XII	08129	VI	32129	VII	56129
15			XII	08159	XII	32159	VI	56159
18			XII	08189	XII	32189	VI	56189
22							VI	56229
27							XII	56279
33							XII	56339
39							XII	56399
47							XII	56479

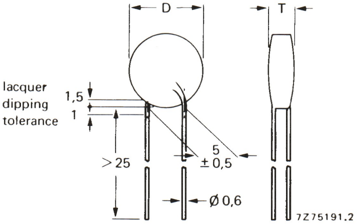


coupling and decoupling — type 2
2222 627

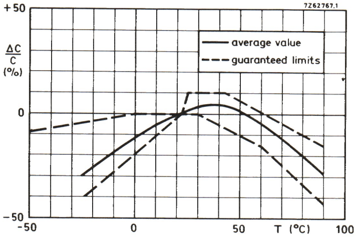
These capacitors are suitable for coupling and decoupling where low self-inductance and high insulation resistance are required.

Capacitance range	100 to 3300 pF
tolerance	−20/+50%
Rated voltage (d.c.)	400 V
Test voltage (d.c.)	1250 V
Category temperature range	−40 to +85 °C
Insulation resistance	> 10 000 MΩ
Tan δ at 1 kHz	< 3,5 %
Climatic category IEC 68	40/085/21

size	D_{max}	T
I	6	3
II	6	3,5
III	6	4
IV	6	4,5
VI	9	3



capacitance pF	size	catalogue no.
100	IV	14101
120	III	14121
150	II	14151
180	II	14181
220	II	14221
270	II	14271
330	II	14331
390	II	14391
470	I	14471
560	I	14561
680	I	14681
820	I	14821
1000	I	14102
1200	I	14122
1500	I	14152
1800	I	14182
2200	VI	14222
2700	VI	14272
3300	VI	14332

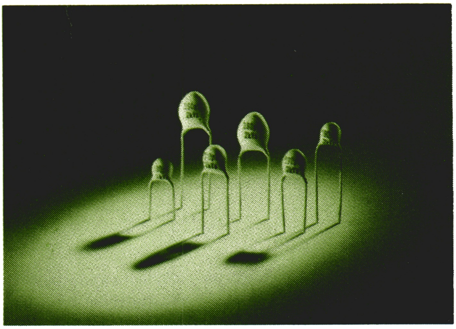


Capacitance change with respect to the value at 20 °C.

ceramic capacitors

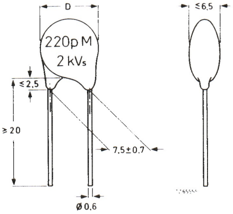
disc

coupling and decoupling — type 2
2212 659 — high voltage



For use in television (line deflection) etc., where high d.c. or pulse voltages are encountered.

	Version	1 kV	2 kV
Capacitance range (E12 series)		33-820	33-560 pF
tolerance		20	10 and 20 %
Rated voltage (d.c.)		1	2 kV
peak (16 kHz)		1	2 kV
Test voltage (d.c.) 2 s		2	4 kV
Category temperature range		−40 to +85 °C	
Insulation resistance		⩾ 10 000 MΩ	
Tan δ at 1 kHz		⩽ 3,5%	
Climatic category IEC 68		40/085/21	
Basic specification		IEC 187	



Body colour: tan.

Composition of the catalogue no.

2212 659 . . . . .

For last 5 digits see code in tables.

1 kV version

capacitance pF	Dmax mm	tolerance 20% mark M; code
33	7	03339
39	7	03399
47	8	03479
56	8	03569
68	7	03689
82	7	03829
100	7	03101
120	8	03121
150	8	03151
180	7	03181
220	7	03221
270	7	03271
330	8	03331
390	8	03391
470	10	03471
560	10	03561
680	11	03681
820	11	03821

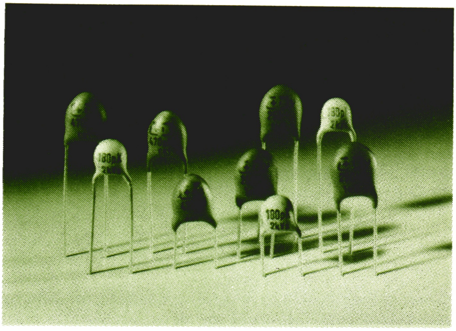
2 kV version

capacitance pF	Dmax mm	tolerance 10% mark K; code	tolerance 20% mark M; code
33	7	00339	01339
39	7	00399	01399
47	7	00479	01479
56	7	00569	01569
68	8	00689	02689
82	8	00829	01829
100	7	00101	01101
120	7	00121	01121
150	7	00151	01151
180	7	00181	01181
220	8	00221	01221
270	8	00271	01271
330	10	00331	01331
390	10	00391	01391
470	11	00471	01471
560	11	00561	01561

coupling and decoupling – type 2
2212 660 – interference suppression
2212 661 – safety

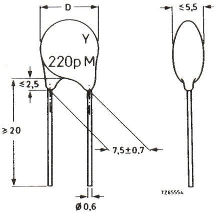
2212 660 is suitable for interference suppression in domestic and other appliances.

2212 661 is suitable for use as the isolating (safety) medium in tv and radio antenna inputs, and other exposed metal parts.



2212 660

Capacitance range (E12 series)	220 to 2200 pF
tolerance	20%
Rated voltage (a.c.)	250 V
Test voltage (a.c.)	1500 V
Category temperature range	–40 to +85 °C
Insulation resistance	⩾ 10 000 MΩ
Tan δ at 1 kHz	⩽ 3,5%
Climatic category IEC 68	40/085/21
Basic specification	IEC 161
Approvals Germany	VDE 0560 part 7/11.67



body colour: tan

capacitance pF	D_{max} mm	catalogue no.
220	8	2212 660 01221
270	7	01271
330	7	01331
390	7	01391
470	7	01471
560	7	01561
680	7	01681
820	8	01821
1000	10	01102
1200	10	01122
1500	10	01152
1800	10	01182
2200	11	01222

2212 661

mechanical drawing as above;
thickness max 7,5 mm
body colour: brown

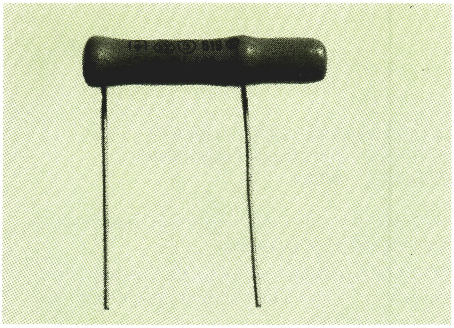
Capacitance range (E12 series)	33-1000 pF
tolerance	see table
Rated voltage (a.c.)	400 V; 125 V (U.S.A.)
Test voltage (a.c.)	2500 V
Category temperature range	–40 to +85 °C
Insulation resistance	⩾ 10 000 MΩ
Tan δ at 1 kHz	⩽ 3,5%
Climatic category IEC 68	40/085/21
Basic specification	IEC 65
Approvals Germany	VDE 0560 part 2/5.70
Sweden	SEMKO
Switzerland	SEV (33 to 220 pF only)
Finland	FEMKO
U.S.A.	U.L 1270/1410 File E 55811 (125 V (a.c.) only)

capacitance pF	tolerance	marking	D_{max} mm	catalogue no.
33	20%	M	8	2212 661 01339
39	20%	M	8	01399
47	20%	M	8	01479
56	20%	M	8	01569
68	20%	M	8	01689
82	20%	M	8	01829
100	20%	M	8	01101
120	20%	M	8	01121
150	20%	M	8	01151
180	20%	M	8	01181
220	20%	M	8	01221
270	–20 to +50%	S	8	02271
330	–20 to +50%	S	8	02331
390	–20 to +50%	S	8	02391
470	–20 to +50%	S	8	02471
560	–20 to +50%	S	11	02561
680	–20 to +50%	S	11	02681
820	–20 to +50%	S	11	02821
1000	–20 to +50%	S	11	02102

ceramic capacitors

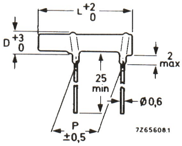
tubular

tuning — type 1 B
coupling and decoupling — type 2
2212 619 — safety

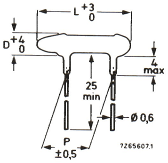


Covering the range 22 to 4700 pF and suitable for earthing rimbands, mains transformers, etc. in tv receivers.

Capacitance range (E12 series)	
type 1 B	22 to 390 pF
type 2	390 to 4700 pF
tolerance	20%
Rated voltage (a.c.)	400 V
Test voltage (a.c.)	2500 V
Category temperature range	−25 to +85 °C
Insulation resistance	⩾ 10 000 MΩ
Tan δ at 1 MHz for type 1 B	⩽ 10 x 10^{-4}
1 MHz for type 2	⩽ 3,5%
Climatic category IEC 68	25/085/21
Basic specification	IEC 65
Approvals Switzerland	SEV 1016, 1959
Germany	VDE 0560, part 2/5.70
Sweden	SEMKO 101 amendment 2
Denmark	DEMKO (permission for application)

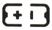


non-insulated



insulated

Marking

manufacturer's trade mark	
VDE mark (Germany)	
SEMKO mark (Sweden)	
SEV mark (Switzerland)	

Approvals:			
type 1 B	insulated	:	VDE, SEMKO, DEMKO, SEV
type 1 B	non-insulated	:	VDE, SEMKO, DEMKO
type 2	insulated	:	SEMKO, DEMKO, SEV
type 2	non-insulated	:	VDE, SEMKO, DEMKO

type 1B (grey)

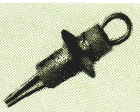
capacitance pF	D	L mm	P	catalogue no. 2212 619 ..... non-insulated	insulated
22	3	18	10	42229	52229
27	3	18	10	42279	52279
33	3	18	10	42339	52339
39	3	18	10	42399	52399
47	3	20	10	42479	52479
56	3	20	10	42569	52569
68	4	20	10	42689	52689
82	4	20	10	42829	52829
100	4	22	12,5	42101	52101
120	4	22	12,5	42121	52121
150	4	24	12,5	42151	52151
180	4	26	15	42181	52181
220	4	30	20	42221	52221
270	4	34	25	42271	52271
330	4	38	27,5	42331	52331
390	4	42	32,5	42391	52391

type 2 (tan)

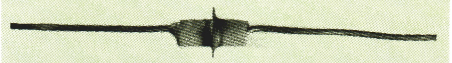
capacitance pF	D	L mm	P	catalogue no. 2212 619 ..... non-insulated	insulated
390	4	22	12,5	62391	72391
470	4	22	12,5	62471	72471
560	4	22	12,5	62561	72561
680	4	22	12,5	62681	72681
820	4	22	12,5	62821	72821
1000	4	22	12,5	62102	72102
1200	4	22	12,5	62122	72122
1500	4	22	12,5	62152	72152
1800	4	24	12,5	62182	72182
2200	4	26	15	62222	72222
2700	4	28	17,5	62272	72272
3300	4	32	22,5	62332	72332
3900	4	36	25	62392	72392
4700	4	40	30	62472	72472

feed-through

decoupling — type 2
2222 700   2222 702



700 series:
split pin feed-through capacitor

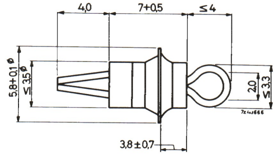


702 series:
lead feed-through capacitor

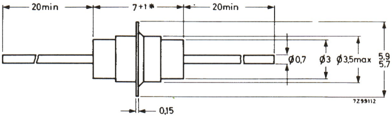
Used for decoupling external connections in tv tuners and other h.f. equipment.

Capacitance range 700 series (E6)	2,5 to 2200 pF
702 series (E6)	2,5 to 4700 pF
tolerance	see tables
Rated voltage (d.c.)	350 V
Test voltage (d.c.)	1050 V
Category temperature range	−40 to +85 °C
Insulation resistance	> 10 000 MΩ
Tan δ at 1 MHz for C ⩽ 68 pF	$< 10 \times 10^{-4}$
at 1 kHz for C > 68 pF	$< 20 \times 10^{-4}$
Climatic category IEC 68	40/085/21

700 series



702 series



* 10^{+1} mm for the 3300 pF capacitor
12^{+1} mm for the 4700 pF capacitor

700 series

capacitance nF	tolerance	catalogue no.
⩽ 2,5		2222 700 00258
3,3	0,5 pF	01338
4,7		01478
6,8	1 pF	02688
10		02109
15	10%	03159
22		03229
33		03339
47		03479
68	20%	04689
100		04101
150		04151
220		04221
330		04331
470		04471
680		04681
1000	−20/+50%	05102
1500		05152
2200		05222

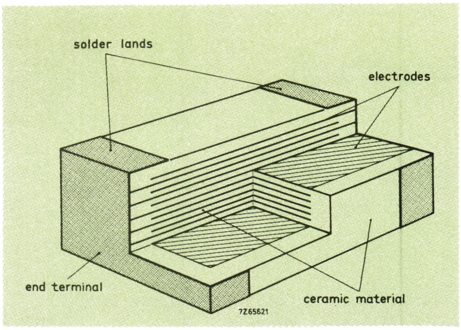
702 series

capacitance pF	tolerance	catalogue no.
⩽ 2,5	0,5 pF	2222 702 04258
3,3		04338
4,7		04478
6,8		04688
10	10%	05109
15		07159
22		07229
33		07339
47		07479
68		07689
100	20%	08101
150		08151
220		08221
330		08331
470		08471
680	−20/+50%	09681
1000		09102
1500		09152
2200		09222
3300		09332
4700		09472

ceramic capacitors

multilayer chip

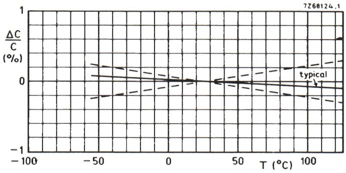
2222 851 to 856



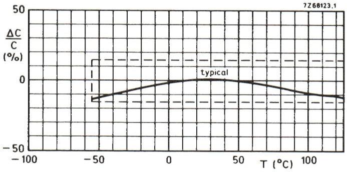
Microminiature multilayer ceramic capacitors with a very high capacitance per unit volume. They are ideal for hybrid integrated circuits where they are used for coupling, by-passing, blocking, frequency discrimination, etc.

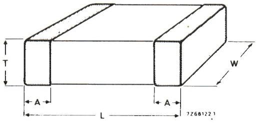
Dielectric	NPO	K1800	
Capacitance range (E12)	10 to 10 000	100 to 470 000	pF
tolerance	10	20	%
Rated voltage (d.c.)	50	50	V
Test voltage (d.c.)	150	150	V
Category temperature range	−55 to +125	−55 to +125	°C
Insulation resistance	R > 100 000		MΩ
for C ≤ 10 000 pF		R > 100 000	MΩ
C > 10 000 pF		RC > 1000	s
Climatic category IEC 68	55/125/56	55/125/56	

NPO



K1800





ΔC with respect to C at 20 °C, versus T.
Dotted lines indicate the limits.

style	L mm	W mm	T_{min} mm	T_{max} mm	A_{min} mm	A_{max} mm	available NPO C values (pF)	available K1800 C values (pF)
0805	2,0 ± 0,2	1,25 ± 0,2	0,51	1,27	0,25	0,75	10 to 270	100 to 22 000
1210	3,2 ± 0,3	2,5 ± 0,2	0,51	1,90	0,3	1,0	47 to 2 700	2 200 to 100 000
1808	4,5 ± 0,3	2,0 ± 0,2	0,51	1,90	0,3	1,0	100 to 3 300	2 200 to 100 000
1812	4,5 ± 0,3	3,2 ± 0,3	0,51	1,90	0,3	1,0	330 to 5 600	4 700 to 220 000
2220	5,7 ± 0,4	5,0 ± 0,4	0,51	1,90	0,3	1,0	470 to 10 000	12 000 to 470 000

Composition of the catalogue no.

2222 . . . .

style code
851 = style 0805
852 = style 1210
854 = style 1808
855 = style 1812
856 = style 2220

tolerance
NPO (COG); 10% 13
K1800 (X7R); 20% 48

first two digits of
capacitance value in pF

factor
9 = 1
1 = 10
2 = 100
3 = 1000
4 = 10 000

variable capacitors

survey

For detailed information
Handbook CM2b

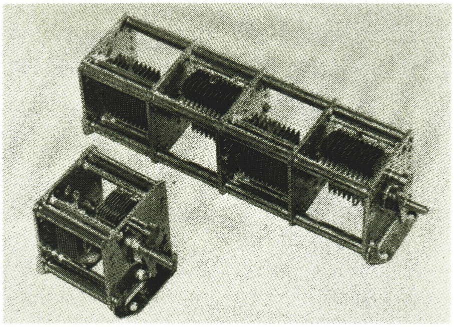
Precision tuning capacitors
Used in the top flight of telecommunication and measuring equipment. They feature high stability under extreme conditions, close law tolerance, and allow design flexibility.

Film dielectric trimmers
State-of-the-art in both design and materials, these capacitors bring the advantages of film dielectric to the trimmer field. While taking the same or less space than conventional trimmers, they offer superior performance and better adjustment means at lower cost.

application	capacitance max C_{min}/ min C_{max} pF	rated d.c. voltage V	temperature coefficient range ppm/ °C	series no.	status	page
Precision tuning capacitors	nom swing 10 to 640	400/1500	20 to 50	805	D	C127
Film dielectric trimmers						
radio	1,4/5,5 to 12/120	250	0 ± 300 −750 ± 300	808	D	C128–C129
for miniature h.f. equipment in measurement and telecommunication, etc.	1/3,5 to 5/60	300	−250 ± 150 −350 ± 75	809 50 809 80 809 90	D	C130–C131
	1,5/5 to 7/100	200/350	0 ± 200	809 70	D	C132

variable capacitors

precision tuning capacitors



2222 805

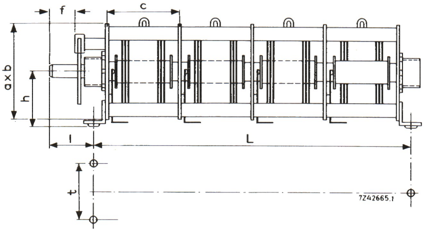
These capacitors are used in the top flight of telecommunication and measuring equipment. They feature high stability under extreme conditions, close law tolerance, and allow design flexibility. We can supply standard products as shown below, or custom designs to meet your specific needs — including special laws and gear mechanisms.

Rated d.c. voltage	50 to 75% of test voltage depending on ambient conditions
Category temperature range	−40 to +85 °C
Temperature coefficient	20 to 50 ppm/ °C
Insulation resistance	> 10 000 MΩ
Contact resistance	⩽ 5 mΩ

	linear law a x b = 40 x 40 mm				**linear law** a x b = 60 x 60 mm				**logarithmic law** a x b = 60 x 60 mm			
	single-stator or differential type		split-stator type		single-stator type		split-stator type		single-stator type		split-stator type	
nom swing pF	C_{min} ± 1 pF pF	d.c. test voltage V	C_{min} ± 1 pF pF	d.c. test voltage V	C_{min} ± 1 pF pF	d.c. test voltage V	C_{min} ± 1 pF pF	d.c. test voltage V	C_{min} ± 1 pF pF	d.c. test voltage V	C_{min} ± 1 pF pF	d.c. test voltage V
10			3	3000								
16	8	2500	3,6	2000								
25	8,5	2000	4	2000			5	4000			5	2500
32							5	3000			5	2500
40	9	1500	4	1600			5	3000			5,5	2000
50							5	2500			5,5	2000
64	9	1000	4	1300			5,5	2000			5,5	1600
80							5,5	2000			5,5	1600
100	10	1000			14,5	2000	5,5	2000	13	1500	5,5	1600
125					15	2000	6	1600	13	1250	5,5	1300
160	11	800			15,5	1500			14,5	1000		
200					16	1250			14,5	1000		
250	11,5	650			16	1250			14	1000		
320					17,5	1000			14	800		
400					19	1000			14	800		
500					20,5	1000			14	650		
640					21,5	800						

Dimensions (mm)

a x b		40 x 40	60 x 60
L	1 gang	45	67
	2 gangs	76,5	117,5
	3 gangs	108	168
	4 gangs	139,5	218,5
t		22	35
c		31,5	50,5
l		16	18
h		22,5	32,5
f		10	14,5



variable capacitors

film dielectric trimmers

2222 808

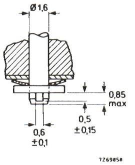
High stability trimmers for consumer or professional use, vertical or horizontal on PCB mounting.

Rated voltage (d.c.)	250 V
Test voltage (d.c.) for 1 minute	500 V
Category temperature range	−40 to +70 °C
Temperature coefficient	see table
Insulation resistance	> 10 000 MΩ
Contact resistance	< 10 mΩ
Tan δ	see table
Climatic category IEC 68	40/070/21
Angle of rotation	180°

Adjustments (see tables opposite)

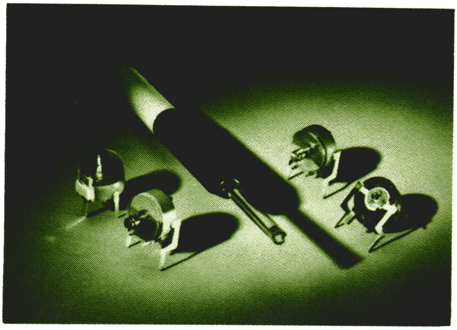
	top	bottom
a	screwdriver	key (detail Z)
b	hexagonal head	key (detail Z)
c	screwdriver	screwdriver
d	hexagonal head	screwdriver

Adjustment tools available



detail Z, turned 90°
see drawings opposite
not for **41121; 44121**
71121; 74121

reference to current ranges pF	guaranteed max C_{min}/min C_{max} pF	max tan δ at C_{max} and at		temperature coefficient ppm/°C	base colour	last five digits of catalogue no.	
		1 MHz	100 MHz			vertical mounting	horizontal mounting
1,2/6	1,4/5,5	10×10^{-4}	25×10^{-4}	−400 ± 300	grey	**11558**	–
1,4/10	2 /10	10×10^{-4}	25×10^{-4}	−200 ± 300	yellow	**11109**	**51109**
1,6/15	2 /15	10×10^{-4}	25×10^{-4}	−200 ± 350	blue	**11159**	–
1,8/15	2,5/15	10×10^{-4}	25×10^{-4}	0 ± 400	blue	**31159; 32159**	**61159**
1,8/22	2 /22	10×10^{-4}	25×10^{-4}	−250 ± 350	green	**11229**	**51229**
2,5/25	3 /22,5	10×10^{-4}	25×10^{-4}	0 ± 400	green	**31229; 32229**	**61229**
2 /30	2 /27	50×10^{-4}	–	−250 ± 300	red	**11279**	**51279**
2 /40	3 /40	–	–	−250 ± 300	violet	**11409**	–
4 /40	5,5/40	10×10^{-4}	25×10^{-4}	−150 ± 350	grey	**31409; 32409**	**61409**
4,5/70	5,5/65	10×10^{-4}	25×10^{-4}	−200 ± 300	yellow	**31659; 32659**	**61659; 64659**
5 /90	6 /80	50×10^{-4}	–	−100 ± 300	red	**31809; 32809**	**61809**
					red	**34809**	**64809**
5 /105	6 /100	50×10^{-4}	–	−100 ± 300	violet	**31101; 32101**	**64101**
8 /130	11 /120	50×10^{-4}	–	0 ± 200	green	**41121; 44121**	–
				−200 ± 200	green	–	**71121; 74121**

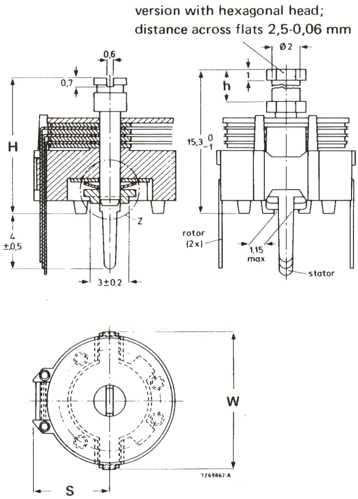


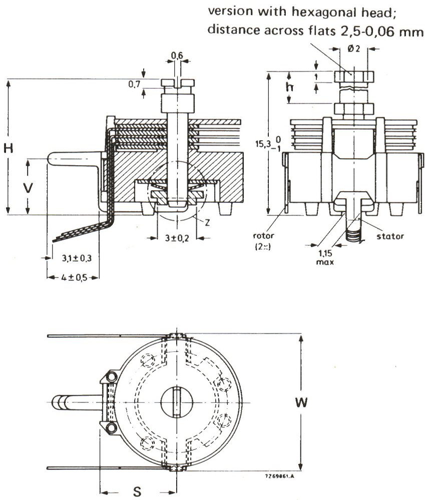
Vertical mounting

catalogue no.	adj.	H max	W max	S max	h
2222 808 **11** . . .	a	10	8	5	—
31 . . .	a	11	10,6	6	—
32 . . .	a	11	10,6	6	—
34809	b	15,3	10,6	6	5,8
41121	c	11	14,1	8,2	—
44121	d	14	14,1	8,2	4,5

Horizontal mounting

catalogue no.	adj.	H max	W max	S max	V max	h
2222 808 **51** . . .	a	10	8	5	—	—
61 . . .	a	11	10,6	6,05	4,2	—
64 . . .	b	15,3	10,6	6,05	4,2	5,8
71121	c	11	14,1	—	5,4	—
74121	d	14	14,1	—	5,4	4,5

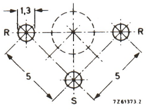

version with hexagonal head;
distance across flats 2,5-0,06 mm
0,6
0,7
H
h
1
Ø2
15,3 0 -1
4 ±0,5
Z
3±0,2
rotor (2x)
1,15 max
stator
W
S
7Z69862 A


version with hexagonal head;
distance across flats 2,5-0,06 mm
0,6
0,7
H
V
h
1
Ø2
15,3 0 -1
Z
3±0,2
3,1±0,3
4±0,5
rotor (2x)
1,15 max
stator
W
S
7Z69861 A

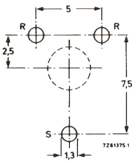
Hole patterns for 2222 808 . . . . .

R = rotor; S = stator; large hole only for bottom adjustment

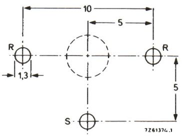
11 . . .


1,3
R
R
5
5
S
7Z61373.2

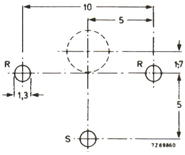
32 . . .


5
R
R
2,5
7,5
S
1,3
7Z61375.1

31 . . . **61** . . .
34809 **64** . . .


10
5
R
R
1,3
5
S
7Z61374.1

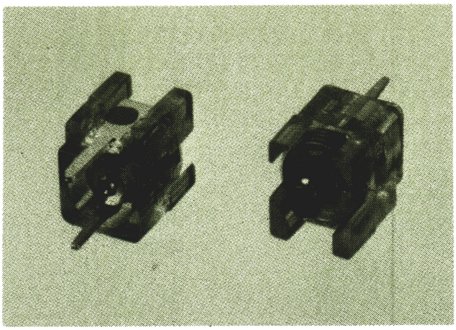
71121 **41121**
74121 **44121**


10
5
R
R
1,7
1,3
5
S
7Z69860

variable capacitors

film dielectric trimmers

2222 809 050
2222 809 080 — high-temperature
2222 809 090

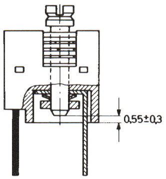


Rated voltage (d.c.)	300 V
Test voltage (d.c.)	600 V
Category temperature range	−40 to +125 °C
Insulation resistance	> 10 000 MΩ
Contact resistance	< 5 mΩ
Angle of rotation	180°
Climatic category IEC 68	40/125/21

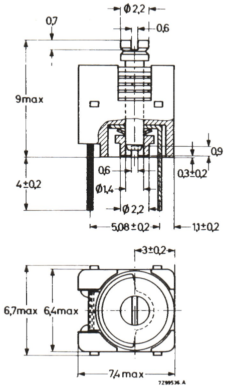
capacitance max C_{min} pF	min C_{max} pF	temperature coefficient ppm/°C	max tan δ at 100 MHz	last two digits of catalogue no. top adjustment	top + bottom adjustment	colour of marking dot on stator
050 series						
1	3,5	−250 ± 150	20 x 10^{-4}	01	04	orange
1,8	10	−300 ± 75	20 x 10^{-4}	02	05	white
2	18	−350 ± 75	40 x 10^{-4}	03	06	red
080 series						
4	40	−250 ± 150	35 x 10^{-4}		02	yellow
5	60	−250 ± 150	35 x 10^{-4}		03	blue
090 series						
1,4	5,5	−250 ± 150	15 x 10^{-4}		01 04	green
2	9	−250 ± 150	15 x 10^{-4}		02 05	white
2	18	−250 ± 150	15 x 10^{-4}		03 06	red

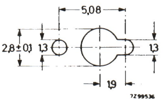
050 series

01
02
03

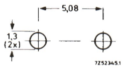


04
05
06

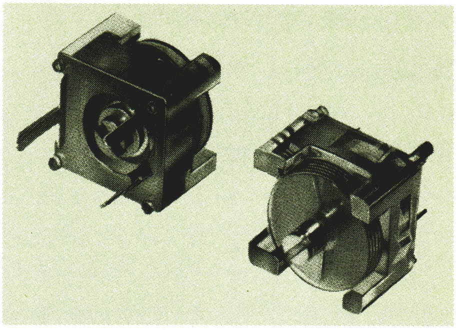

Ø2,2
0,7
0,6
9max
0,9
0,6
0,3±0,2
4±0,2
Ø1,4
Ø2,2
5,08±0,2
1,1±0,2
3±0,2
6,7max
6,4max
7,4max
7Z99536 A


5,08
2,8±0,1
1,3
1,3
1,9
7Z99536

Hole pattern for type with top and bottom adjustment.

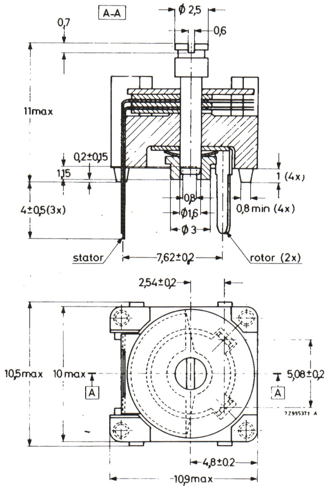

5,08
1,3 (2x)
7Z52345.1

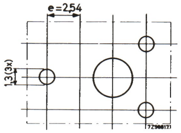
Hole pattern for type with top adjustment.



080 series

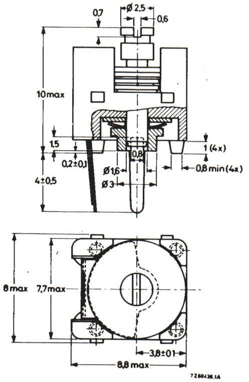
080 series

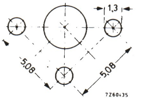

A-A
ϕ 2,5
0,7
0,6
11max
0,2±0,15
1,15
1 (4x)
4±0,5(3x)
0,8
ϕ1,6
ϕ 3
0,8 min (4x)
stator
7,62±0,2
rotor (2x)
2,54±0,2
10,5max
10 max
A
5,08±0,2
A
7Z99537 A
4,8±0,2
10,9max


e=2,54
1,3(3x)
7Z98817

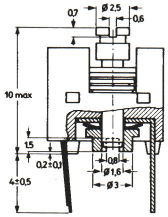
Hole pattern;
large hole is only
necessary for bottom
adjustment.

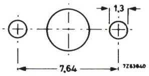
090 series


0,7
ϕ 2,5
0,6
10max
1,5
0,2±0,1
1 (4x)
0,8
ϕ1,6
ϕ3
0,8 min(4x)
4±0,5
8max
7,7max
3,8±0,1
8,8 max
7Z60436.1A


1,3
5,08
5,08
7Z60435

Hole pattern for the
three-pin versions **01, 02** and **03**


0,7
ϕ 2,5
0,6
10 max
1,5
0,2±0,1
4±0,5
0,8
ϕ1,6
ϕ3

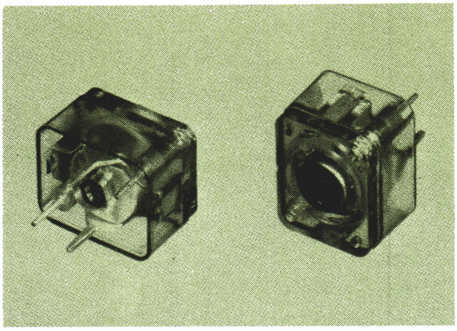

1,3
7,64
7Z63840

Hole pattern for the
two-pin versions **04, 05** and **06**

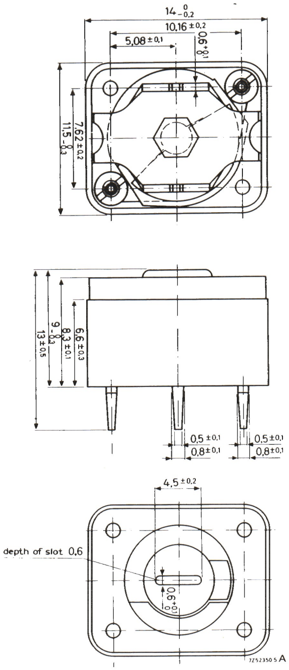
variable capacitors

film dielectric trimmers

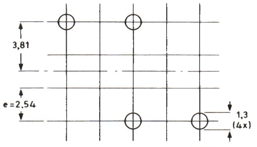
2222 809 070 — high-temperature



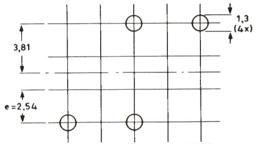
Rated voltage (d.c.)	50% of test voltage
Category temperature range	−40 to +125 °C
Temperature coefficient	0 ± 200 ppm/ °C
Insulation resistance	> 10 000 MΩ
Contact resistance	< 5 mΩ
Tan δ at 1 MHz	$< 10 \times 10^{-4}$
Climatic category IEC 68	40/125/21
Angle of rotation	180°


$14_{-0,2}^{\;0}$
10,16 ± 0,2
5,08 ± 0,1
$0,6^{+0,1}_{\;0}$
$11,5_{-0,3}$
7,62 ± 0,2
13 ± 0,5
$9_{-0,3}$
8,3 ± 0,1
6,6 ± 0,3
0,5 ± 0,1
0,8 ± 0,1
0,5 ± 0,1
0,8 ± 0,1
4,5 ± 0,2
depth of slot 0,6
$0,6^{+0,1}_{\;0}$
7Z52350.5 A

type	capacitance max C_{min} pF	 min C_{max} pF	d.c. test voltage V	tan δ $\times 10^{-4}$ at 100 MHz	last two digits of catalogue no.
single-stator	2,5	20	700	17	04
	4	40	700	17	08
	5	60	400	25	11
	6	80	400	25	13
	7	100	400	25	15
split-stator	1,5	5	700	17	01
	2	10	700	17	02
	3	15	400	25	03
	3	20	400	25	05
	3	25	400	25	07
differential	2,5	20	700	17	06
	4	40	700	17	09
	5	60	400	25	12
	6	80	400	25	14
	7	100	400	25	16


3,81
e = 2,54
1,3
(4x)
7Z73727

single-stator


1,3
(4x)
3,81
e = 2,54
7Z73728

split-stator and differential

CONTENTS COMPONENTS FOR RADIO, AUDIO, TV

For detailed information
Handbook CM3

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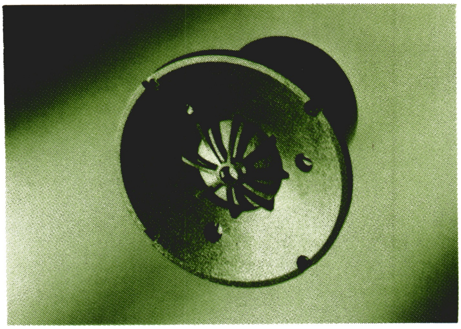
loudspeakers

high power—high-fidelity

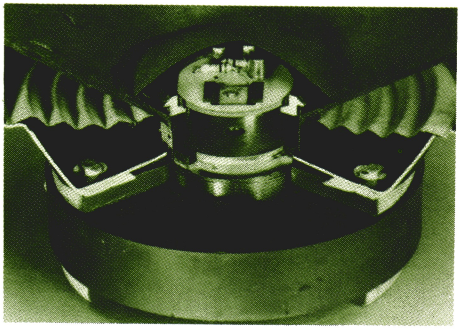
to DIN 45 500

System powers tabulated below are for complete two or three-way systems making use of the listed loudspeakers; corresponding cross-over networks are listed on page C136.



AD0211/Sq.

type	status	system power W	impedance Ω	resonance frequency Hz	rated frequency range Hz	overall dia. mm	baffle hole dia. mm	total depth mm	surround /dome material	magnet system	mass kg
Tweeter 1" (dome)											
AD0140/T4 T8	D	20/40	4 8	1200	**1600–20000**	94	75	25	poly-carb.	FXD	0,25
AD0141/T4 T8	D	20/50	4 8	1450	2000–20000	94	75	25	textile	FXD	0,25
AD0162/T8 T15	D	20/80	8 15	1000	2000–22000	94	75	32	poly-carb.	FXD	0,5
AD0163/T8 T15	D	20/80	8 15	1300	2000–**22000**	94	75	32	textile	FXD	0,5
AD01600 /T4 AD01605 /T8 AD01610 /T15	N	20/80	4 8 15	1300	2000–20000	94	85	32	textile	FXD	0,5
Tweeter 2" (cone)											
AD2090/T4 T8 T15	D	20	4 8 15	1300	**3000–20000**	51	44	29	paper	Ticonal	0,1
AD2095/T4 T8 T15	D	20/40	4 8 15	1400	3000–**20000**	51	44	28	paper	Ticonal	0,07
AD2290/T4 T8 T15	D	20	4 8 15	1300	**3000–20000**	51	44	29	paper	Ticonal	0,1
AD2295/T4 T8 T15	D	20/40	4 8 15	1400	3000–**20000**	51	44	28	paper	Ticonal	0,07
Tweeter 2¼" (cone)											
AD2273/T4 T8	N	10	4 8	1000	**1000–**18000	58	52	29	paper	FXD	0,07
AD2274/T4 T8	N	10	4 8	1000	1000–18000	58	52	29	paper	FXD	0,07
Squawker 2"											
AD0211/Sq4 Sq8	D	60	4 8	270	**550–**5000	134	110	108	textile	FXD	1,0
Squawker 5"											
AD5060/Sq4 Sq8	D	40	4 8	210	**500–**5000	129	96	107	textile	FXD	0,8
AD5061/Sq4 Sq8	D	80	4 8	680	**1300–**5000	129	95	50	textile	FXD	0,8



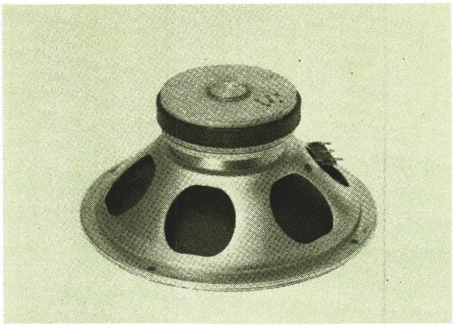
Cut-away view of high-fidelity woofer AD80670.

type	status	system power W	impe-dance Ω	resonance frequency Hz	rated frequency range Hz	overall dia. mm	baffle hole dia. mm	total depth mm	surround /dome material	magnet system	mass kg
Woofer 4″											
AD4050/W4 W8	N	15	4 8	60	35–2000	100	95	55	rubber	Ticonal	0,42
Woofer 5″											
AD5060/W4 W8	D	10	4 8	60	50–5000	129	108	56	rubber	FXD	0,7
Woofer 7″											
AD7060/W4 W8	D	30	4 8	45	40–3000	166	141	68	rubber	FXD	0,7
AD7066/W4 W8	D	40	4 8	45	60–3000	166	141	72	rubber	FXD	1,15
Woofer 8″											
AD80600/W4 W8	N	40	4 8	42	30–5000	205	176	84	rubber	FXD	0,8
AD80650/W4 W8	N	50	4 8	39	50–6000	205	176	84	rubber	FXD	1,15
AD80670/W4 W8 AD80670/MFB	N	60 60 50	4 8 4	32 32 37	40–5000 25–1000	205	180	88	rubber	FXD	1,3
Woofer 10″											
AD1065/W4 W8	D	30	4 8	20	40–3000	261	227	113	rubber	FXD	1,8
AD10100/W4 W8	D	40	4 8	25	35–800	261	227	131	rubber	FXD	3,0
Woofer 12″											
AD12200/W4 W8	N	80	4 8	22	40–2000	311	279	119	rubber	FXD	3,0
AD12250/W4 W8	N	100	4 8	24	50–3000	311	279	121	rubber	FXD	3,8
AD12600/W4 W8	N	40	4 8	22	40–3500	311	279	111	rubber	FXD	1,32
AD12650/W4 W8	N	60	4 8	18	35–2000	311	279	115	rubber	FXD	1,87

loudspeakers

high power—full-range

double cone



type	status	system power W	impedance Ω	resonance frequency Hz	rated frequency range Hz	overall dia. mm	baffle hole dia. mm	total depth mm	surround material	magnet system	mass kg
5″											
AD5061/M4 **M8**	D	15	4 8	85	75–20000	129	108	55	textile	FXD	0,665
7″											
AD7062/M4 **M8**	D	30	4 8	45	40–18000	166	141	68	rubber	FXD	0,68
AD7063/M4 **M8**	D	15	4 8	55	60–18000	166	141	69	textile	FXD	0,745
8½″											
9710/M8	D	20	8	50	45–19000	217	195	96	paper	FXD	1,75
10″											
AD1065/M4 **M8** **M15**	D	10	4 8 15	55	60–18000	261	227	113	paper	FXD	1,52
12″											
AD1265/M4 **M8** **M15**	D	20	4 8 15	45	55–18000	315	278	134	paper	FXD	1,8
AD12100/M4 **M8** **M15**	D	25	4 8 15	45	35–13000	315	278	152	paper	FXD	3,3
AD12100/HP4 **HP8**	D	50	4 8	60	45–12000	315	278	152	textile	FXD	3,27

The 8½ inch type 9710/M8 unit, with a Ferroxdure magnet of 105 mm diameter (mass 400 g), is an extremely sensitive speaker which has, over a number of years, become the most popular type for hi-fi hobbyists. It features an exceptionally smooth response in the range 45 Hz to 19 kHz. Power handling capacity of the 9710/M8 is 20 W in a sealed enclosure up to 30 litres in volume, and up to 10 W in bass-reflex enclosures of over 30 litres.

cross-over networks
passive radiator

Cross-over networks

system	type	status	catalogue no.	max power W	impedance Ω	cross-over frequency Hz	slope dB/oct	dimensions mm	overall height mm
2-way	**ADF2400/4** **8**	D	3104 207 10110 10100	20	4 8	2400	low 6 high 6	**83 x 42,5**	**35**
2-way	**ADF2000/4** **8**	D	3104 207 10130 10120	20	4 8	2000	low 6 high 12	**83 x 42,5**	**35**
3-way	**ADF600-5000/4** **8**	D	3104 207 10150 10140	40	4 8	**600/5000**	low 6 mid 6 high 12	**140 x 60**	**36**
2-way	**ADF1500/4** **8**	D	3104 207 10210 10220	80	4 8	**1500** **1800**	low 6 high 12	83 x 42,5	35
2-way	**ADF3000/4** **8**	D	3104 207 10230 10240	80	4 8	3000 4000	low 6 high 12	83 x 42,5	35
3-way	**ADF700/2600/4** **8**	D	3104 207 10250 10260	80	4 8	650/2800 700/2600	low 6 mid 12 high 12	140 x 60	36
3-way	**ADF700/3000/4** **8**	D	3104 207 10270 10280	80	4 8	700/3000	low 6 mid 12 high 12	140 x 60	36

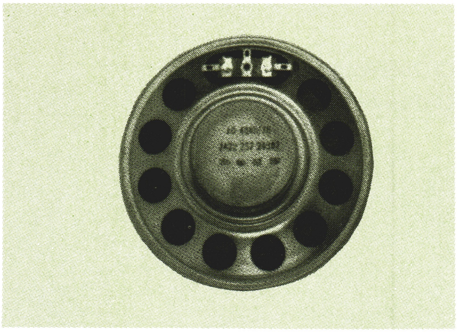
Passive radiator 8″ – AD8001

2422 259 80001	effective cone area	$2{,}5 \times 10^{-2}$ m^2
	total moving mass	31,3 g
	total mass	0,235 kg
	total depth	64 mm
	baffle hole diameter	180 mm
	overall diameter	205 mm
	surround material	rubber

loudspeakers

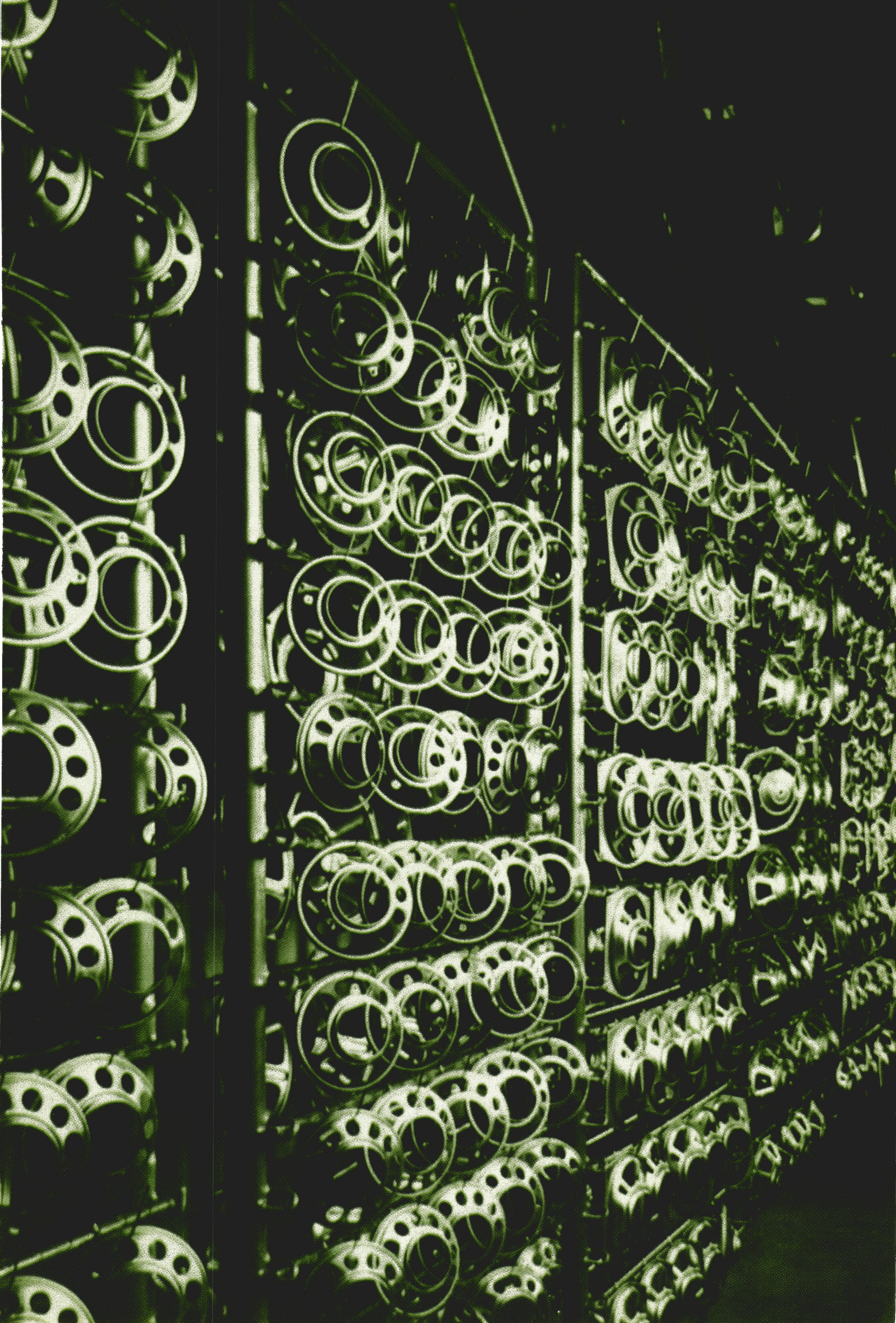
medium power–full-range

round



type	status	max power W	impe-dance Ω	resonance frequency Hz	rated frequency range Hz	overall dia. mm	baffle hole dia. mm	total depth mm	surround material	magnet system	mass kg
4″											
AD4080/X4 X8 X15 X25	D	3	4 8 15 25	165	165–12000	105	96	39	paper	FXD	0,25
AD4480/X4 X8 X15	D	3	4 8 15	165	125–12000	105	96	39	paper	FXD	0,25
AD4481/X4	D	8	4	140	90–14000	105	96	39	textile	FXD	0,25
AD4085/X4 X8	D	3	4 8	150	80–14000	104	96	36	paper	FXD	0,16
5″											
AD5081/M4 M8 M15 M25	D	6	4 8 15 25	135	70–20000	120	108	49	paper	FXD	0,26
AD5081/X4 X8 X15 X25	D	6	4 8 15 25	140	60–14000	120	108	49	paper	FXD	0,26
7″											
AD7080/M4 M8 M15	D	6	4 8 15	105	80–15000	166	141	58	paper	FXD	0,29
X4 X8		6	4 8	115	85–10000	166	141	58	paper	FXD	0,29
AD7091/M4 M8 M400 M800	D	3	4 8 400 800	105	80–18000	166	141	44	paper	Ticonal	0,22
AD7091/X4 X8 X800	D	3	4 8 800	115	85–10000	166	141	44	paper	Ticonal	0,22
8″											
AD8080/M4 M8 M15	D	6	4 8 15	75	55–18000	206	176	68	paper	FXD	0,37
AD8080/X4 X8	D	6	4 8	95	70–10000	206	176	68	paper	FXD	0,37
AD8081/M4 M8	D	8	4 8	75	50–14000	206	176	68	paper	FXD	0,37
AD8081/X4 X8	D	8	4 8	95	70–11000	206	176	68	paper	FXD	0,37

Loudspeaker frames ready for plating.

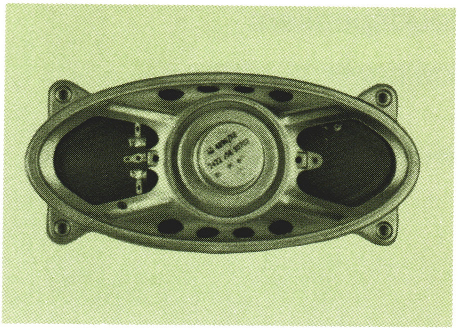


loudspeakers

medium power–full-range

oval

type	status	max power W	impedance Ω	resonance frequency Hz	rated frequency range Hz	overall size mm	baffle hole size mm	total depth mm	surround material	magnet system	mass kg
3″ x 5″											
AD3591/X4	D	3	4	180	85–12000	76 x 131	66 x 121	43	paper	Ticonal	0,13
X8			8								
X15			15								
X25			25								
X50			50								
AD3595/X4	N	3	4	170	90–15000	76 x 131	66 x 121	40	paper	Ticonal	0,13
X8			8								
X15			15								
X25			25								
3″ x 8″											
AD3880/X4	D	4	4	120	90–15000	82 x 205	72 x 195	51	paper	FXD	0,3
X8			8								
X15			15								
AD3890/X4	D	4	4	120	90–15000	82 x 205	72 x 195	56	paper	Ticonal	0,21
X8			8								
X15			15								
X25			25								
X70			70								
X800			800								
3½″ x 6″											
AD4692/X4	D	4	4	140	80–13000	95 x 155	82 x 140	55	paper	Ticonal	0,14
X8			8								
X15			15								
X25			25								
AD4682/X4	D	6	4	140	80–13000	95 x 155	82 x 140	51	paper	FXD	0,25
X8			8								
X15			15								
X25			25								
AD4685/X4	N	4	4	140	70–15000	95 x 155	82 x 140	49	paper	FXD	0,12
X8			8								
4″ x 6″											
AD4681/M4	D	6	4	135	100–20000	102 x 154	89 x 141	48	paper	FXD	0,26
M8			8								
M25			25								
AD4681/X4	D	6	4	140	100–12000	102 x 154	89 x 141	48	paper	FXD	0,26
X8			8								
X15			15								
X25			25								

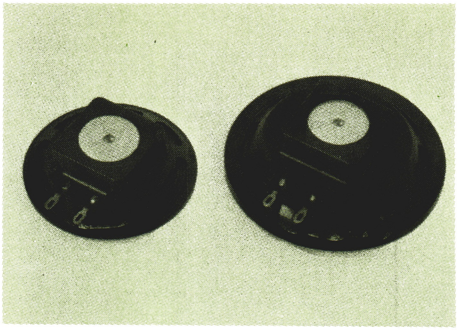


type	status	max power W	impe-dance Ω	resonance frequency Hz	rated frequency range Hz	overall size mm	baffle hole size mm	total depth mm	surround material	magnet system	mass kg
4" x 6" (continued)											
AD4691/M4	D	4	4	135	100–20000	102 x 154	89 x 141	52	paper	Ticonal	0,16
M8			8								
M15			15								
M25			25								
M800			800								
AD4691/X4	D	4	4	140	100–12000	102 x 154	89 x 141	52	paper	Ticonal	0,16
X8			8								
X15			15								
X25			25								
4" x 8"											
AD4890/X4	D	10	4	110	55–13000	96 x 210	82 x 192	54	paper	Ticonal	0,23
X8			8								
X15			15								
X25			25								
5" x 7"											
AD5780/M4	D	6	4	100	70–20000	133 x 183	110 x 160	57	paper	FXD	0,32
M8			8								
M15			15								
M25			25								
AD5780/X4	D	6	4	115	85–10000	133 x 183	110 x 160	57	paper	FXD	0,32
X8			8								
X15			15								
X25			25								
AD5790/M4	D	4	4	100	70–19000	133 x 183	110 x 160	62	paper	Ticonal	0,22
M8			8								
M15			15								
AD5790/X4	D	4	4	115	85–10000	133 x 183	110 x 160	62	paper	Ticonal	0,22
6" x 9"											
AD6980/M4	D	6	4	77	60–20000	161 x 234	149 x 220	67	paper	FXD	0,36
M8			8								
AD6980/X4	D	6	4	90	70–10000	161 x 234	149 x 220	67	paper	FXD	0,36
X8			8								

loudspeakers

low power

round



type	status	max power W	impe-dance Ω	resonance frequency Hz	rated frequency range Hz	overall dia. mm	baffle hole dia. mm	total depth mm	surround material	magnet system	mass kg
1¼″											
AD0198/Z8	D	0,2	8	700	550–13000	31	26,5	16	paper	Ticonal	0,017
Z15			15								
Z25			25								
2″											
AD2099/Z8	D	0,3	8	420	325–13000	50	45,5	18	paper	Ticonal	0,021
Z15			15								
Z25			25								
2½″											
AD2071/Z4	D	1	4	360	180–4000	64	59	20	paper	FXD	0,07
Z8			8								
Z15			15								
Z25			25								
3″											
AD3071/Y4	D	2	4	250	100–6000	81	72	28	paper	FXD	0,07
Y8			8								
Y15			15								
Y25			25								
AD3370/Y4	C	1	4	250	190–7000	81	72	28	paper	FXD	0,075
Y8			8								
Y25			25								
Y150			150								
4″											
AD4072/X4	D	3	4	170	80–15000	105	96	29	paper	FXD	0,079
X8			8								
X15			15								
X25			25								
AD4472/X4	D	3	4	170	80–15000	105	96	29	paper	FXD	0,087
X8			8								
X15			15								
X25			25								
AD4090/X8	D	2	8	190	140 8000	105	96	37	paper	Ticonal	0,125
X15			15								

coding system

AD ●● ●●/●●

nominal cone size (inches) and shape of flange

magnet system

audio response

rated impedance (Ω)

01	= 1 to 1¼	dome
02	= 2	dome
10	= 10	round
12	= 12	round
20	= 2 to 2½	round
22	= 2 to 2½	square
30	= 3	round
33	= 3	square
35	= 3 x 5	oval
38	= 3 x 8	oval
40	= 4	round
44	= 4	square
46	= 4 x 6	oval
48	= 4 x 8	oval
50	= 5	octagonal
57	= 5 x 7	oval
69	= 6 x 9	oval
70	= 7	octagonal
80	= 8	octagonal

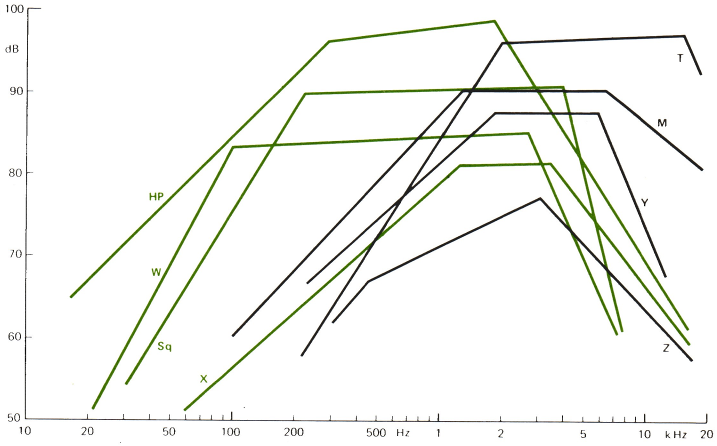
		diameter mm	mass g
10, 11	= FXD	102	420
40	= FXD	62	100
50	= Ticonal	25	60
60, 600, 605	= FXD	72	260
61, 610, 62	= FXD	72	260
620, 63, 630	= FXD	72	260
65, 650, 66	= FXD	90	450
660, 67, 670	= FXD	90	450
70, 71, 72	= FXD	31 *	20
80, 81, 82	= FXD	53	100
85	= FXD	46	53
90, 91, 92	= Ticonal	18	27
95	= Ticonal	14	13
99	= Ticonal	10	6
100	= FXD	130	1050
200	= FXD	124	850
250	= FXD	138	1150

* square

high power	= HP
double cone, smooth response over wide frequency range	= M
squawkers; for mid-range frequencies	= Sq
tweeter; for high frequencies	= T
woofer; for very low frequencies	= W
notably higher sensitivity at about 3 kHz	= Z
notably higher response level in the region 2 to 6 kHz	= Y
as Z, but wider frequency range	= X

4
8
15
25
50
70
150
400
800

Approximated response curves and their relationship.



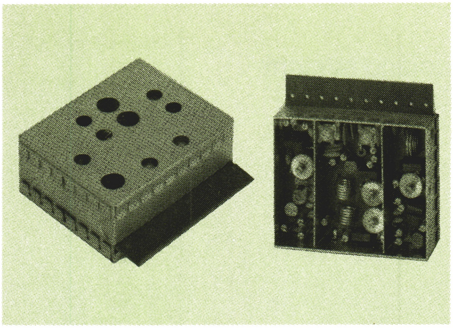
7Z71654

tuners

f.m. radio – diode tuning

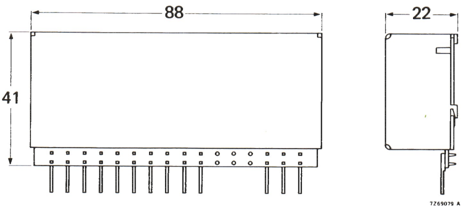
A range of variable capacitance diode tuners covering the inexpensive, medium, and hi-fi classes. They are manufactured in large series with consequent advantages in quality and in price. The use of fully automated production facilities also promotes consistently high quality standards.

For detailed information
Handbook CM3

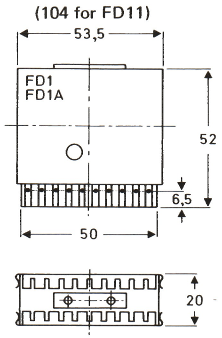


type catalogue no. status	**AP2157/01** 3122 137 15230 N	**AP2158** 3122 137 15410 N	**FD1A *** 4312 020 80030 N	**FD11** 4312 020 80050 N	
frequency range	87,5 to 108	87,5 to 108	87,5 to 108	87,5 to 108	MHz
oscillator frequency	$f_{osc} > f_{aer}$	$f_{osc} > f_{aer}$	$f_{osc} > f_{aer}$	$f_{osc} > f_{aer}$	
input impedance	75	75	60/240	75	Ω
d.c. voltage					
supply	15	15	12	20	V
tuning	3 to 27	3 to 27	3,8 to 28	30	V
stabilization	1,4	1,4	–	5	V
i.f. frequency	10,7	10,7	10,7	10,7	MHz
i.f. bandwidth (–3 dB)	180	180	250	300	kHz
i.f. circuit	4-fold	2-fold	–	2-fold	
gain	20	30	30	40	dB
noise figure	6,5	6,5	5,5	4,8	dB
number of i.f. circuits	4	4	2	2	

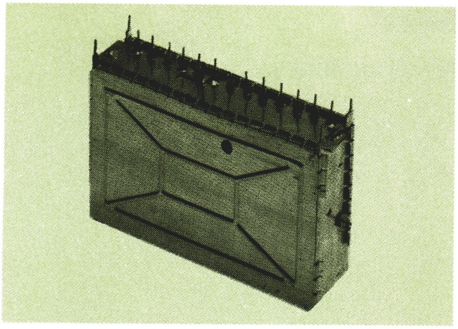
* Also available without AFC
type FD1
catalogue no. 4312 020 80020.



pitch of the connecting pins
2,54 mm (0,1 inch)



tv – diode tuning



This range of tuners covers all C.C.I.R. systems, including the U.K. system and the C.C.I.R. derivatives: Eastern Europe, Italy, Ireland, Australia, New Zealand, South Africa and South America. Versions are available for n-p-n and p-n-p a.g.c. direction. All tuners are pluggable to facilitate servicing.

type no.	**ELC1042/05**			**ELC1043/05**		**ELC2000**	**ELC2004**
catalogue no.	2422 542 10720			2422 542 10460		2422 542 12000	3122 128 64171
status	C			C		C	N
C.C.I.R.	A	B	I	G and I		B and G	B and G
		v.h.f.		u.h.f.		v.h.f. and u.h.f.	v.h.f. and u.h.f.
channel coverage							
band I	B1 to B5	E2 to E4	IA to IC	—		E2 to C	NZ1 to R4
band III	B6 to B14	E5 to E12	ID to IJ	—		E5 to E12	M4 to E12
band IV and V	—	—	—	21 to 69		E21 to E69	E21 to E69
i.f. frequency (MHz)							
picture	34,65	38,9	39,5	38,9	39,5	38,9	38,9
sound	38,15	33,4	33,5	33,4	33,5	33,4	33,4
input impedance (Ω)		75; 300		75; 300		75; 300	75; 300
d.c. voltage (V)							
supply ± 10%		12		12		12	11
tuning		1 to 25		1 to 25		0,5 to 28	0,5 to 28
switching		12		—		12	11
power gain (dB)							
band I		⩾ 18		—		⩾ 25	⩾ 25
band III		⩾ 18		—		⩾ 25	⩾ 25
band IV and V		—		⩾ 18		⩾ 25	⩾ 25
typical noise figure (dB)							
band I		7,5		—		6,5	5,5
band III		7		—		6,5	6
band IV and V		—		6,5		9,5	8
a.g.c. range (dB)							
band I		⩾ 40		—		⩾ 40	⩾ 40
band III		⩾ 40		—		⩾ 40	⩾ 40
band IV and V		—		⩾ 30		⩾ 35	⩾ 30
dimensions max (mm)							
thickness		28		28		28,6	28,6
length		96		96		109	109
height		58		58		67	67

pitch of the connecting pins
2,54 mm (0,1 inch)

tuners

tv - diode tuning

type no.	**ELC2005**	**ELC2060**	**ELC2070**	**12ET5632/03**
catalogue no.	3122 128 66921	3122 128 56990	3122 128 54200	9012 745 63200
status	N	D	D	C
C.C.I.R.	B and G v.h.f.	B and G v.h.f. and u.h.f.	I and I v.h.f. III and u.h.f.	G u.h.f.
channel coverage				
band I	NZ1 to R4	0 to 4; 45 to 101 MHz	–	–
band III	M4 to E12	5 to 11; 101 to 222 MHz	4 to 13	–
band IV and V	–	28 to 63; 526 to 814 MHz	21 to 69	E21 to E68
i.f. frequency (MHz)				
picture	38,9	36,875	38,9	38,9
sound	33,4	31,375	32,9	33,4
input impedance (Ω)	75; 300	75; 300	75, 300	75
d.c. voltage (V)				
supply ± 10%	11	12	12	12
tuning	0,5 to 28	0,5 to 28	0,5 to 28	0,5 to 28
switching	11	12	–	–
power gain (dB)				
band I	≥ 25	≥ 25	–	–
band III	≥ 25	≥ 25	≥ 25	–
band IV and V	–	≥ 25	≥ 25	≥ 20
typical noise figure (dB)				
band I	5,5	7	–	–
band III	6	7	6,5	–
band IV and V	–	9	9,5	7,5
a.g.c. range (dB)				
band I	≥ 40	≥ 40	–	–
band III	≥ 40	≥ 40	≥ 40	–
band IV and V	–	≥ 30	≥ 30	≥ 30
dimensions max (mm)				
thickness	28,6	28,6	28,6	16
length	109	109	109	82
height	67	67	67	50

pitch of the connecting pins
2,54 mm (0,1 inch)

type no.	**12ET5732/03**	**UF1**	**VF1**	**ELC3082 ***	**U321 */U321LO ***
catalogue no.	9012 745 73200			3122 127 19680	3122 128 54240
status	C	D	D	D	D/N
C.C.I.R. system	B v.h.f.	F u.h.f.	F v.h.f.	M and N v.h.f. (R.T.M.A.)	G and I u.h.f.
channel coverage					
band I	E2 to E4	—	F2 to F4	A2 to A6	—
band III	E5 to E12	—	E5 to E12, F5 to F12	A7 to A13	—
band IV and V	—	E21 to E69	—	—	E21 to E69
i.f. frequency (MHz)					
picture	38,9	32,7	28,05	45,75	38,9 39,5
sound	33,4	39,2	39,2	41,25	33,4 33,5
input impedance (Ω)	75	75	75	75/300	75
d.c. voltage (V)					
supply ± 10%	12	12	12	12	12
tuning	0,5 to 28	0,5 to 28	0,5 to 28	0,5 to 28	0,5 to 28
switching	—	—	12	12	—
power gain (dB)					
band I	⩾ 20	—	⩾ 17	⩾ 24	—
band III	⩾ 20	—	⩾ 19	⩾ 25	—
band IV and V	—	⩾ 15	—	—	⩾ 18
typical noise figure (dB)					
band I	6	—	6	7	—
band III	6	—	6	7,5	—
band IV and V	—	8	—	—	7,5
a.g.c. range (dB)					
band I	⩾ 30	—	⩾ 40	⩾ 40	—
band III	⩾ 30	—	⩾ 40	⩾ 40	—
band IV and V	—	⩾ 30	—	—	⩾ 30
dimensions max (mm)					
thickness	16	16	21	28	18
length	82	82	82	96	82
height	50	50	50	58	50

pitch of the connecting pins
2,54 mm (0,1 inch)

* These large-signal tuners are equipped with a P-I-N diode attenuator in the input circuit.

tuners

tv - diode tuning

type no.	U322 */U322LO *		V311 *		V314 *	V315/V315LO
catalogue no.	3122 128 54250/64851		3122 218 50890		3112 218 51211	3122 218 51170/51200
status	D/N		N		N	N
C.C.I.R. system	G and H	I and K	B and	I	B and G	B and G
	u.h.f.		v.h.f.		v.h.f.	v.h.f. (cable systems)
channel coverage						
band I	—		NZ1 to E4	IA to IC	E2 to C	E2 to S1
band III	—		E5 to E12	ID to IJ	M4 to E12	S2 to S19
band IV and V	E21 to E69		—	—	—	—
i.f. frequency (MHz)						
picture	38,9	39,5	38,9	39,5	38,9	38,9
sound	33,4	33,5	33,4	33,5	33,4	33,4
input impedance (Ω)	75		75		75	75
d.c. voltage (V)						
supply ± 10%	12		12		12	12
tuning	0,5 to 28		0,5 to 28		1 to 28	1 to 28
switching	—		—		12	12
power gain (dB)						
band I	—		≥ 23		≥ 20	≥ 20
band III	—		≥ 23		≥ 23	≥ 20
band IV and V	≥ 20		—		—	—
typical noise figure (dB)						
band I	—		6,5		5	8
band III	—		6,5		6,5	8
band IV and V	7,5		—		—	—
a.g.c. range (dB)						
band I	—		≥ 40		≥ 40	≥ 40
band III	—		≥ 40		≥ 40	≥ 40
band IV and V	≥ 30		—		—	—
dimensions max (mm)						
thickness	18		18		18	18
length	82		82		82	82
height	50		50		50	50

pitch of the connecting pins
2,54 mm (0,1 inch)

* These large-signal tuners are equipped with a P-I-N diode attenuator in the input circuit.

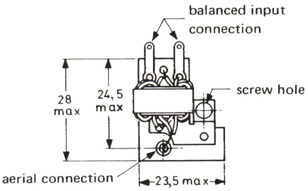
aerial input transformers

converting 300 Ω asymmetric to 75 Ω symmetric

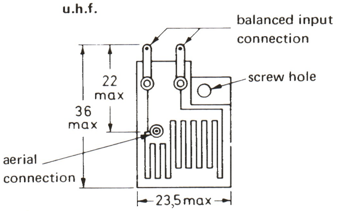
for tuner type no.	aerial input transformer type no.		catalogue no.
ELC1042/05	**ELC1094**	v.h.f.	2422 542 10941
ELC1043/05	**ELC1095**	u.h.f.	10951
ELC2000	**ELC1094**	v.h.f.	10941
	ELC2092	u.h.f.	12921
ELC2060 ELC2070	**ELC1094**	v.h.f.	10941
	ELC2092	u.h.f.	12921
ELC3082	**ELC1094**	v.h.f.	10941

Aerial input transformer

v.h.f.


balanced input connection
screw hole
28 max
24,5 max
aerial connection
23,5 max

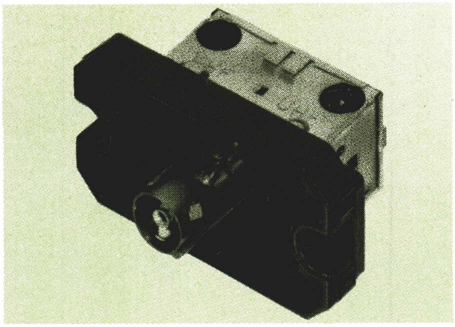
u.h.f.


balanced input connection
screw hole
22 max
36 max
aerial connection
23,5 max

tuners
coaxial aerial input assemblies 75Ω

This range of coaxial aerial input assemblies is unique in that it is fully approved as meeting all current national European safety regulations for consumer equipment. Deposition of the relevant approval numbers is sufficient to obtain approval for apparatus in which the assemblies are fitted. Relevant approvals (numbers available on request) include:

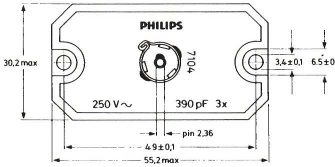
VDE	SEMKO
SEV	NEMKO
KEMA	E.I.
DEMKO	B.S.I

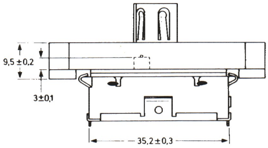


catalogue no.	attenuation max v.h.f. and u.h.f. dB	reflection max v.h.f. I %	v.h.f. III %	u.h.f. %	height max mm
3122 127 10260	1	15	15	25	22
3122 127 10450	1	25	25	30	29
3122 127 14730	1	35	15	35	29

type selection

catalogue no.	filter		attenuation MHz	dB
3122 127 10260	without	v.h.f. and u.h.f. IN — assembly — OUT v.h.f. and u.h.f.	–	–
3122 127 10450	with	v.h.f. and u.h.f. IN — assembly OUT v.h.f. u.h.f.	470 700 100 230	⩾ 13 typ 23 typ 40 ⩾ 15
3122 127 14730	with high-pass	as . . . 10260	1 5 10	typ 60 typ 40 ⩾ 25





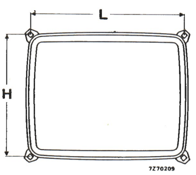
black and white tv

picture tubes

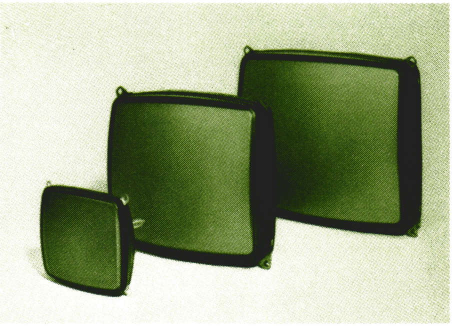
● tube with quick-heating cathode –
a picture in 5 seconds

For detailed information
Handbook ET8

type	status	def. angle deg.	neck diameter mm	typical operating conditions V_f/I_f V/mA	 V_{g2} V	 V_{g4} V	 V_a kV	 V_{KR} V	overall length max mm	useful screen diag. min mm	lug position (see next page) Fig.	 A mm
9 INCH (9V)												
● **9VAMP**	D	90	20	11/140	130	0 – 130	10	30 – 50	227	229	–	–
12 INCH (12V)												
● **A31-410W**	C	110	20	11/140	250	0 – 350	12 to 15	32 – 58	233	295	1	27,6
● **A31-510W**	D	110	20	11/140	130	0 – 130	12 to 15	30 – 50	233	295	1	27,6
12VBHP4	D	110	20	11/140	130	0 – 130	12 to 15	30 – 50	240	292,2	–	–
12VBJP4	D	90	20	11/140	130	0 – 130	12 to 15	30 – 50	280	292,2	–	–
14 INCH (13V)												
● **A34-510W**	D	110	20	11/140	130	0 – 130	12 to 15	30 – 50	247	322	1	32
17 INCH (16V)												
A44-120W	C	110	28,6	6,3/300	400	0 – 400	20	36 – 66	291	413	3	40
A44-171W	C	110	28,6	6,3/450	400	0 – 400	18	36 – 66	291	413	2	32
● **A44-510W**	D	110	20	11/140	130	0 – 130	12 to 15	30 – 50	288	413	3	40
● **A44-520W**	D	110	28,6	6,3/240	130	0 – 130	20	42 – 62	291	413	3	40
16VBRP4	C	110	28,6	6,3/450	130	0 – 300	18	30 – 62	291	413	2	32
● **16VCBP4**	D	110	20	11/140	130	0 – 130	15	30 – 50	288	413	2	32
● **16VCFP4**	D	110	28,6	6,3/240	130	0 – 130	20	42 – 62	291	413	2	32



type	L x H mm
9 inch	198,4 x 149,2
12 inch	267,5 x 204,4
14 inch	290 x 226
17 inch	363,5 x 288,5
20 inch	414 x 331
24 inch	496 x 392



type	status	def. angle deg.	neck diameter mm	typical operating conditions V_f/I_f V/mA	 V_{g2} V	 V_{g4} V	 V_a kV	 V_{KR} V	overall length max mm	useful screen diag. min mm	lug position (see below) Fig.	 A mm
20 INCH (19V)												
A50-120W	C	110	28,6	6,3/300	400	0 – 400	20	36 – 66	319	473	3	45
A50-123W	C	110	28,6	6,3/300	400	0 – 400	20	36 – 66	319	473	2	30
● **A50-520W**	D	110	28,6	6,3/240	130	0 – 130	20	42 – 62	319	473	3	45
19VGYP4	C	110	28,6	6,3/240	130	0 – 130	20	42 – 62	319	473	2	34
19VCHP4	C	110	28,6	6,3/450	400	0 – 400	20	36 – 66	319	473	2	30
● **19VFWP4**	D	110	28,6	6,3/240	130	0 – 130	20	42 – 62	319	473	2	30
24 INCH (23V)												
A61-120W	C	110	28,6	6,3/300	400	0 – 400	20	36 – 66	370	577,5	3	38,5
A61-123W	C	110	28,6	6,3/300	400	0 – 400	20	36 – 66	370	577,5	2	38,5
● **A61-520W**	D	110	28,6	6,3/240	130	0 – 130	20	42 – 62	370	577,5	3	38,5
● **A61-522W**	D	110	28,6	6,3/240	130	0 – 130	20	42 – 62	370	577,5	2	38,5

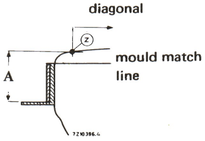

diagonal
(z)
A
mould match line
7Z10396.4

Fig.1

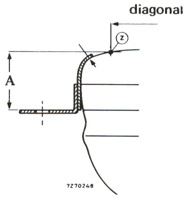

diagonal
z
A
7Z70248

Fig.2

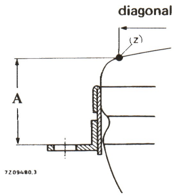

diagonal
(z)
A
7Z09480.3

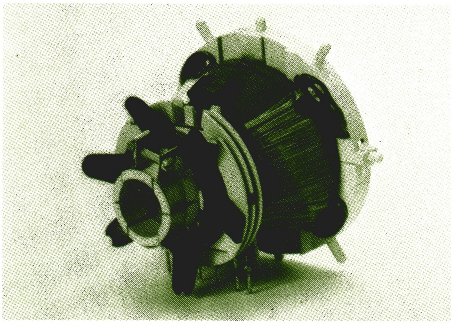
Fig.3

black and white tv

recommended combinations

	consumer				professional (see cathode-ray tubes)		
Picture tube	**A31-410W** **A31-510W**	**A44-120W** **A44-520W**	**A50-120W** **A50-520W**	**A61-120W** **A61-520W**	**M17-140W**	**M24-100W** **M31-130W**	**M38-120W**
deflection angle (deg.)	110	110	110	110	70	90	110
neck diameter (mm)	20	28	28	28	28	28	28
screen diagonal (cm)	31	44	50	61	17	24/31	38
screen diagonal (inch)	12	17	20	24	7	9/12	15
Deflection unit	**AT1074**	**AT1040/15**			**AT1071/07**	**AT1071/03**	**AT1038/40**
Line output transformer	**AT2140**	**AT2048/12**			**AT2102/02**	**AT2102/02**	**AT2102/04**
Line output transistor (see semiconductors)	**BU407**	**BU205**			**BD160**	**BD160**	**BU426**
Line driver transformer	**AT4043/56**	**AT4043/87**					**AT4043/59**
Linearity control		**AT4042/14**			**AT4036**	**AT4036**	**AT4042/08**

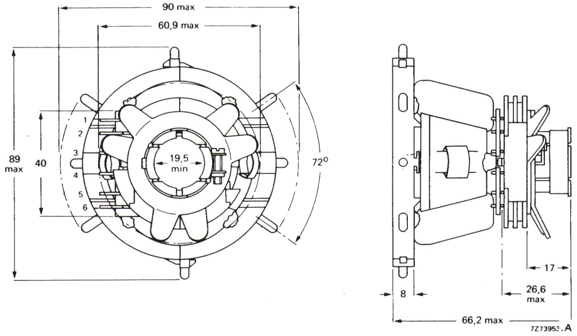
deflection units



AT1074

For detailed information
Handbook CM3

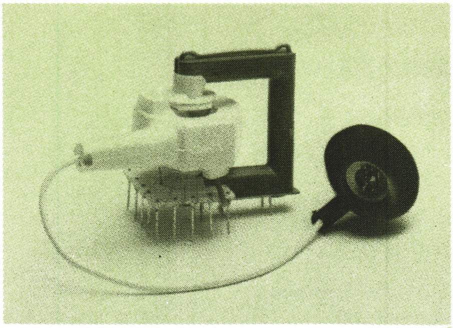
type	**AT1038/40**	**AT1040/15**	**AT1071/03**	**AT1071/07**	**AT1074**	
catalogue no.	3122 137 17530	3122 137 12160	3122 137 17070	3122 137 17080	3122 137 15270	
status	N	D	N	N	N	
Deflection angle	110	110	90	70	110	deg.
Inductance						
line coils	0,69	3,32	0,093	0,087	0,255	mH
field coils	14,1	17	14	10,4	7,9	mH
Resistance						
line coils	1,1	6,1	0,15	0,14	0,56	Ω
field coils parallel	7,6	7,5	6,75	4,2	2,7	Ω
series	30,4	–	27	16,8	–	Ω
Sensitivity						
deflection current edge to edge						
at an e.h.t. of	17	18	16	16	11	kV
in line direction	4,4	2,3	9,3	6,7	5,02	A(p-p)
in field direction	1,08	1,1	0,9	0,84	1,1	A(p-p)
Dimensions						
length a	83,5	75,4	90	90	66,2	mm
flared end o.d. b	123	108,5	128	128	90	mm
clamping ring i.d. c	29,7	29,68	29,7	29,7	19,5	mm



AT1074

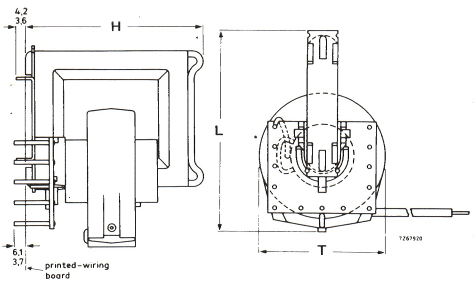
black and white tv

line output transformers

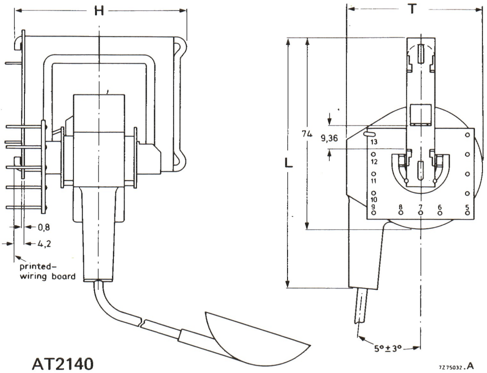


AT2140

type	AT2048/12	AT2102/02	AT2102/04	AT2140	
catalogue no.	3122 138 31650	3122 138 35610	3122 138 35740	3119 108 31000	
status	D	N	N	N	
Supply					
voltage	188	12	24	10,4	V
current	212	920	810	860	mA
Output					
e.h.t. current min	35	30	30	25	μA
e.h.t. voltage max	17,7	16	17	10,2	kV
e.h.t. internal resistance	4	6	6	< 5,5	MΩ
Auxiliary voltages	−300 (peak)	6,3 (r.m.s.)	6,3 (r.m.s.)	11,2 (r.m.s.)	V
	+60 (peak)	12,6 (r.m.s.)	25 (d.c.)	+ 350 (d.c.)	V
	−60 (peak)	70 (d.c.)	70 (d.c.)	+ 100 (d.c.)	V
	7,7 (r.m.s.)	800 (d.c.)	800 (d.c.)	+ 13 (d.c.)	V
				+ 25 (d.c.)	V
Line deflection					
current	2,2	9,5	4,65	4,9	A(p-p)
Line output transistor	**BU205**	**BU426**	**BU426**	**BU407**	
booster diode		**BYZ10-800**	**BYZ10-800**		
e.h.t. rectifier	stack	incorporated	incorporated	incorporated	
Dimensions					
T	47,5	78	78	52	mm
L	78,6	74	74	96	mm
H	67	65	65	66	mm


4,2
3,6
H
L
6,1
3,7
printed-wiring board
T
7Z67920

AT2048/12

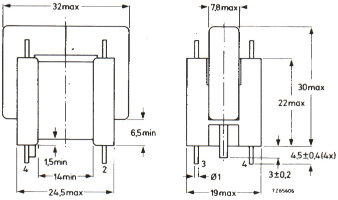

H
0,8
4,2
printed-wiring board
T
74
9,36
L
13
12
11
10
9
8
7
6
5
5°±3°
7Z75032.A

AT2140

line driver transformer
linearity control units

Line driver transformers

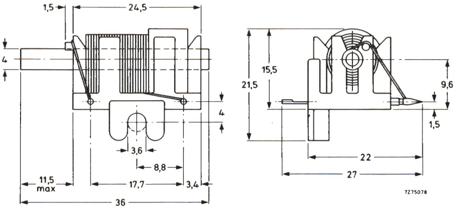
type	AT4043/56 (12 V)	AT4043/59 (24 V)	AT4043/87	
catalogue no.	3111 108 32290	3111 138 93520	3122 138 26060	
status	N	N	D	
inductance	**5,8**	6,1	76 ± 12%	mH
transformation ratio	**4:1**	**4,18:1**	28,7:1	
max operating temperature	95	95	95	°C


32max
6,5min
1,5min
14min
24,5max
4
2
7,8max
30max
22max
4,5±0,4(4x)
3±0,2
3
4
Ø1
19max
7Z65606

AT4043/87

Linearity control units

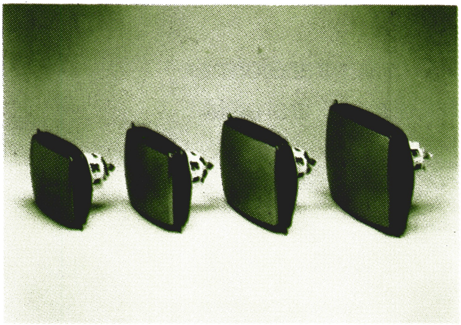
type	AT4036	AT4042/08	AT4042/14	
catalogue no.	3122 108 39270	3122 138 28650	3112 208 30410	
status	D	D	D	
adjustment range	1,05–1,95	8–15	–	V
pre-adjusted	–	–	17	V(p-p)
deflection current	6	4,65	2,2	A(p-p)
recommended damping resistor	220	820	1500	Ω


1,5
24,5
4
4
3,6
8,8
11,5 max
17,7
3,4
36
21,5
15,5
9,6
1,5
22
27
7Z75078

AT4042/14

colour tv

picture tubes

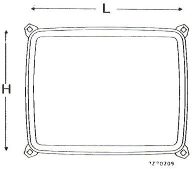


- Hi-Bri
- Soft Flash
- 110° deflection angle
- self-converging
- in-line guns
- quick-heating cathodes
- built-in magnetic shield
- push-through mounting
- bi-potential focusing
- no N-S correction

For detailed information
Handbook ET8

size	type	status	max overall length	min useful screen diag.	typical operating conditions				
					V_f/I_f	$V_{a,\,g5,\,g4}$	V_{g3}	V_{g2}	V_k
			mm	mm	V/mA	kV	kV	V	V
Hi-Bri and Soft Flash					6,3/730	25	4,0 to 4,8	465 to 705	110 to 165
22 inch	**A56-510X**	N	380	530,6					
26 inch	**A66-510X**	N	418	617,8					
Standard version in Soft Flash									
20 inch	**A51-500X**	D	358	480					
22 inch	**A56-500X**	C	380	530,6					
26 inch	**A66-500X**	C	418	617,8					

base: 12-pin base according to IEC 67-I-47a, type 2
anode contact: small cavity contact J 1-21, according to IEC 67-III-2



type	L x H mm
A51-500X	434 x 337
A56-500X	476,5 x 370
A56-510X	476,5 x 370
A66-500X	549 x 422
A66-510X	549 x 422

recommended combinations for 20AX display system

Picture tube (quick-heating cathodes; in-line electron guns)	**A51-500X**	**A56-510X** **A56-500X**	**A66-510X** **A66-500X**
deflection angle (degree)	110	110	110
screen diagonal (cm)	51	56	66
(inch)	20	22	26
Deflection unit	**AT1085**	**AT1083/01**	**AT1080**
Multipole unit		**AT1081**	
Degaussing			
degaussing coil for **A51-500X, A56-500X** and **A56-510X**		**3122 138 75940**	
degaussing coil for **A66-500X** and **A66-510X**		**3122 138 75580**	
dual PTC thermistor		**2322 662 98009**	
Power supply			
mains filtering coil *		**AT4043/55**	
mains transformer		**TS561/1**	
switched-mode driver transformer		**AT4043/45**	
switched-mode transformer		**AT2098/01**	
Line output transformer		**AT2076/30**	
Linearity control unit		**AT4042/38**	
Parabola coil for **A51-500X** (line deflection)		**AT4044/30**	
Class-D filter choke for **TDA2600** (field deflection)		**AT4043/35**	
East-West correction			
bridge coil		**AT4043/38**	
loading coil		**AT4044/20**	
Tolerance compensation			
balancing coil		**AT4044/26**	
4-pole adjusting coil		**AT4044/27**	
Delay lines		**DL50; DL51; DL52** **DL53; DL60; DL61;** **DL700; DL710**	

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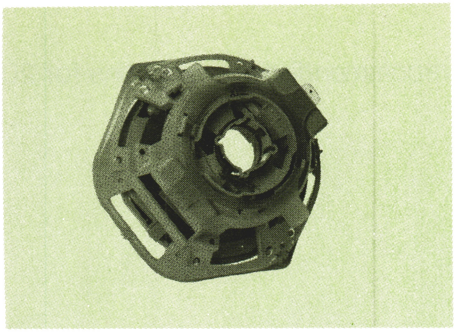
* Separate data available.

colour tv

deflection

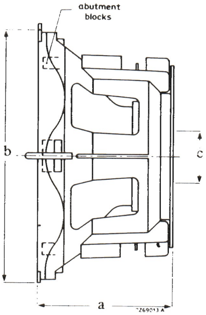


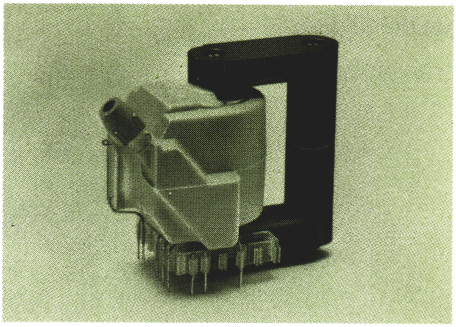
AT1080

For detailed information
Handbook CM3

Deflection units

type	AT1080	AT1083/01	AT1085	
catalogue no.	3122 137 14000	3122 137 15760	3122 137 15660	
status	D	D	D	
Deflection angle	110	110	110	deg
Inductance				
line coils	1,11	1,14	1,14	mH
field coils	3,5	3,9	3,9	mH
Resistance				
line coils	1,2	0,9	0,9	Ω
field coils	3,0	3,36	3,36	Ω
Sensitivity				
deflection current edge to edge				
at an E.H.T. of	25	25	25	kV
in line direction	6,3	6,2	6,2	A(p-p)
in field direction	3,4	3,4	3,4	A(p-p)
4-pole unit				
resistance	1,6	1,4	1,4	Ω
line sensitivity	± 34	± 25	± 23	mm/A
field sensitivity	± 23	± 18	± 16	mm/A
Dimensions				
length a	104,5	104,5	104,5	mm
flared end o.d. b	197,8	197,8	197,8	mm
clamping ring i.d. c	38,2	38,2	38,2	mm





Line output transformer for transistor drive

type	**AT2076/30**
catalogue no.	3122 138 35121
status	N

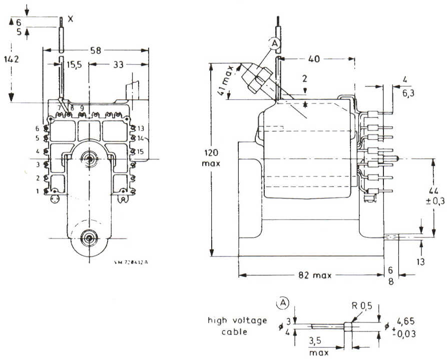
Supply		
voltage	148	V
current	460	mA

Output		
e.h.t. current	50	μA
e.h.t. voltage	25	kV
e.h.t. internal resistance	2	MΩ

Taps in primary	+520	V(peak)	these pulses have a d.c. level of B-plus
	+335	V(peak)	
	+105 (+233)	V(d.c.)	

Auxilary voltages	+160	V(peak)
	−160	V(peak)
	−335	V(peak)
	7,6	V(r.m.s.)

Line deflection current	6,5	A(p-p)
Load inductance	1,12	mH
Fly-back time	11,4	μs

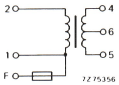

X
6
5
142
58
15,5
33
7
8
9
6
5
4
3
2
1
13
14
15
VM 728412 A
A
40
41 max
2
4
6,3
120
max
44
±0,3
13
82 max
6
8
A
R 0,5
high voltage
cable
ϕ 3
4
ϕ 4,65
±0,03
3,5
max

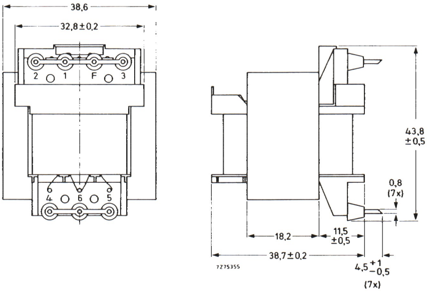
colour tv

transformers

Mains transformer

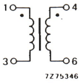
type	**TS561/1**	
catalogue no.	3122 138 34551	
status	N	
primary voltage	(2-F)	220 V
secondary voltage	(4-6 = 6-5)	17,3 V

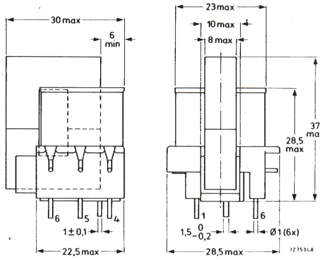

2
1
F
4
6
5
7Z75356


38,6
32,8 ± 0,2
2 1 F 3
6 4 6 5
43,8 ± 0,5
0,8 (7x)
18,2
11,5 ± 0,5
38,7 ± 0,2
4,5 +1 −0,5 (7x)
7Z75355

Switched-mode driver transformer with mains isolation

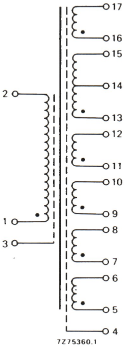
type	**AT4043/45**	
catalogue no.	3122 138 90290	
status	N	
inductance (primary, 1-3)		⩾ 15 mH
leakage inductance (secondary, 4-6)		⩽ 6 μH
transformation ratio (1/3:4/6)		5:1
max operating temperature		115 °C

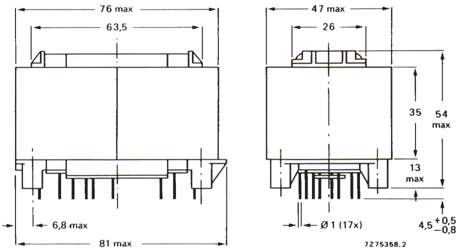

1
3
4
6
7Z75346


30 max
6 min
23 max
10 max
8 max
37 max
28,5 max
6 5 4
1 ± 0,1
22,5 max
1 6
1,5 0 −0,2
Ø 1 (6x)
28,5 max
7Z75348

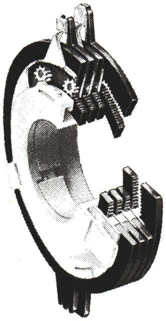
Switched-mode transformer with mains isolation

type	**AT2098/01**
catalogue no.	3122 138 90311
status	N
inductance, primary (1-2)	7 mH ± 10%
leakage inductance (1-2)	36 μH
max working temperature	115 °C
saturation current	⩾ 2,5 A
transformation ratio	
1/2:5/6	0,86
1/2:7/8	1,2
1/2:9/10	5,6
1/2:11/12	9
1/2:13/14	22,5
1/2:13/15	11,3
1/2:16/17	45


2
1
3
17
16
15
14
13
12
11
10
9
8
7
6
5
4
7Z75360.1


76 max
63,5
6,8 max
81 max
47 max
26
35
54 max
13 max
Ø 1 (17x)
4,5 +0,5 −0,8
7Z75368.2

adjustment and correction

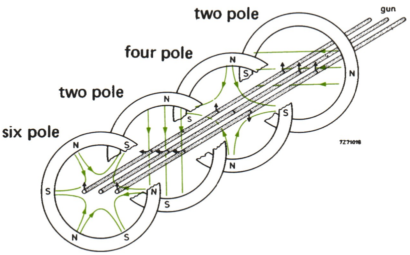


Multipole unit with four ring-shaped permanent magnets: for colour purity, raster symmetry, and two for static convergence adjustments. The unit clamps immediately behind the deflection unit.

Multipole unit

type	**AT1081**
catalogue no.	3122 137 56060
status	D

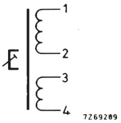
horizontal beam displacement for colour purity (2-pole)	⩾ 45 μm
static convergence	
red opposite to blue in any direction (4-pole)	⩾ 8 mm
red-blue with respect to green in any direction (6-pole)	⩾ 4 mm
vertical displacement for optimum straightness of the horizontal lines (2-pole)	⩾ 5 mm
outer diameter	125,3 mm
inner diameter	38,2 mm
thickness	21,7 mm

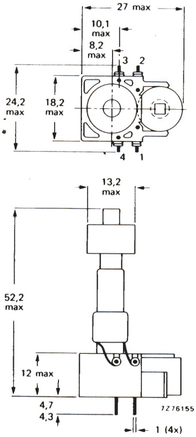

two pole
four pole
two pole
six pole
gun
N
S
7Z71018

Linearity control unit

type	**AT4042/38**
catalogue no.	3122 138 76570
status	D

The correction voltage is pre-adjusted to 23,5 V ± 2,5% at a saw-tooth current of 6,4 A peak-to-peak, frequency 15 625 Hz, flyback ratio 18% (without S-correction), flowing through winding 1-2. The voltage between pins 2 and 3 (pins 1 and 4 interconnected) is then 28,5 V ± 10%.

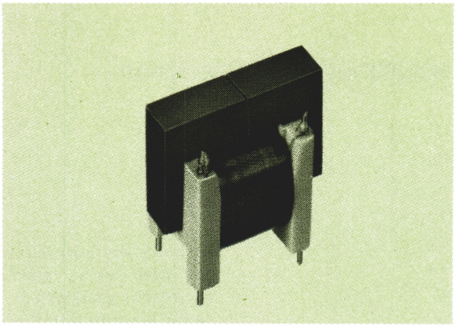

1
2
3
4
7Z69289


27 max
10,1 max
8,2 max
3
2
24,2 max
18,2 max
4
1
13,2 max
52,2 max
12 max
4,7
4,3
1 (4x)
7Z76155

Pins 1 and 4 should be interconnected on the printed-wiring board.

colour tv

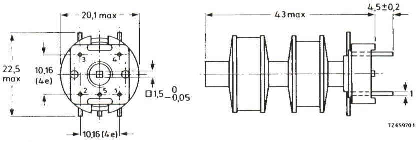
adjustment and correction

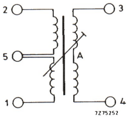


Bridge coil AT4043/38

Parabola adjuster

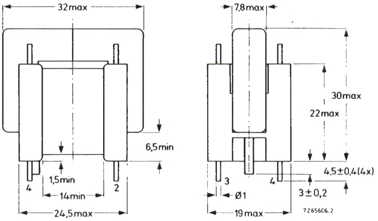
type		**AT4044/30**	
catalogue no.		3122 138 75120	
status		D	
inductance between	pins 1 and 5	105 – 435	μH
	pins 2 and 5	65 – 13	μH
	pins 4 and 3 at L_{5-1} max	420	μH
	pins 4 and 3 at L_{2-5} max	270	μH
resistance between	pins 2 and 1	0,92	Ω
	pins 3 and 4	1,2	Ω

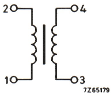

20,1 max
22,5 max
10,16 (4e)
10,16 (4e)
□1,5 $_{-0,05}^{0}$
43 max
4,5±0,2
1
7Z65970 1


2
3
5
A
1
4
7Z75252

Bridge coil

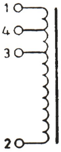
type		**AT4043/38**	
catalogue no.		3122 138 73330	
status		D	
inductance between pins 1 and 2		425	μH ± 10%
d.c. resistance between pins 1 and 2		0,24	Ω
	pins 3 and 4	0,16	Ω
ratings			
voltage		400	V (p-p)
current		6,7	A (p-p)
		1,8	A (r.m.s.)
max operating temperature		100	°C

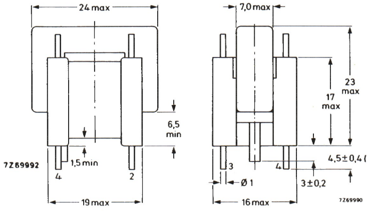

32 max
6,5 min
1,5 min
14 min
24,5 max
4
2
7,8 max
30 max
22 max
4,5±0,4 (4x)
3±0,2
3
4
Ø1
19 max
7Z65606.2

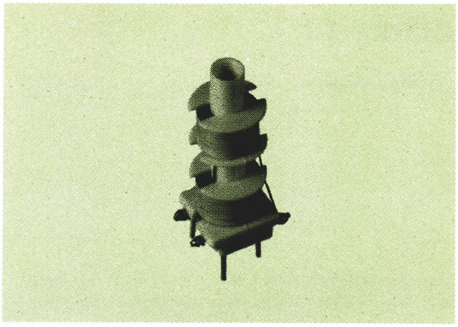

2
4
1
3
7Z65179

Class-D filter choke

type	**AT4043/35**	
catalogue no.	3122 138 74010	
status	D	
inductance between pins 1 and 2	220	μH ± 12%
resistance between pins 1 and 2	0,15	Ω
maximum peak-to-peak current	3,6	A
max operating temperature	100	°C

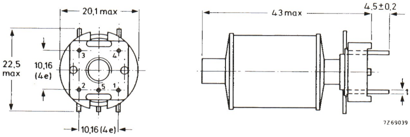


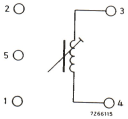

24 max
6,5 min
1,5 min
4
2
19 max
7Z69992
7,0 max
23 max
17 max
4,5±0,4 (4x)
3±0,2
3
4
Ø1
16 max
7Z69990



East-West correction loading coil

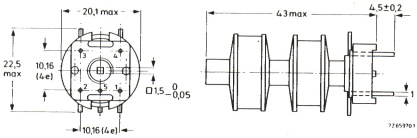
type	**AT4044/20**	
catalogue no.	3122 138 71891	
status	D	
inductance between pins 3 and 4	1 – 5,3	mH
resistance between pins 3 and 4	2	Ω
max operating temperature	95	°C

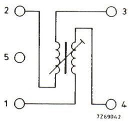

20,1 max
22,5 max
10,16 (4e)
3
4
2
5
1
10,16 (4e)
43 max
4,5±0,2
1
7Z69039


2
5
1
3
4
7Z66115

Balancing coil

type	**AT4044/26**	
catalogue no.	3122 138 71910	
status	D	
inductance between pins 1 and 4	13 – 63	μH
pins 2 and 3	63 – 13	μH
d.c. resistance between pins 1 and 4	0,15	Ω
pins 2 and 3	0,15	Ω
max operating temperature	95	°C


20,1 max
22,5 max
10,16 (4e)
3
4
2
5
1
10,16 (4e)
□1,5 $^{0}_{-0,05}$
43 max
4,5±0,2
1
7Z65970.1


2
5
1
3
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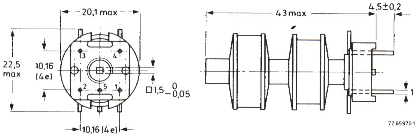
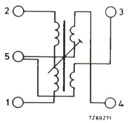
7Z69042

4-pole adjusting coil

type	**AT4044/27**	
catalogue no.	3122 138 72390	
status	D	
inductance between pins 3 and 5	33 – 150	μH
pins 4 and 5	150 – 33	μH
d.c. resistance between pins 1 and 2	0,23	Ω
pins 3 and 4	0,18	Ω
max operating temperature	95	°C


20,1 max
22,5 max
10,16 (4e)
3
4
2
5
1
10,16 (4e)
□1,5 $^{0}_{-0,05}$
43 max
4,5±0,2
1
7Z65970.1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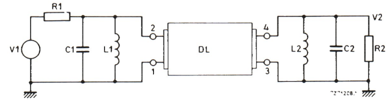
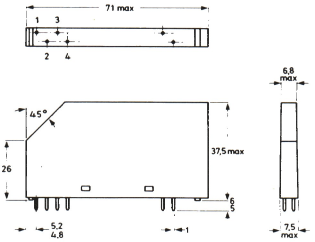
colour tv

delay lines



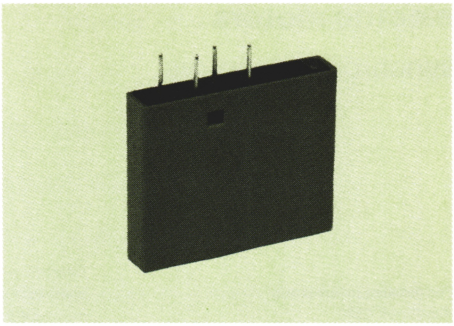
Maintain accurate phase relationship between input and output for the whole life of the receiver. Our delay lines fit nicely between our chrominance ICs.

type	DL50	DL51	DL52	DL53	
catalogue no. 4322	026 95500	026 95510	026 95520	026 95530	
status	M	M	C	C	
Application	European PAL	European PAL/SECAM	Argentine PAL	Brazilian PAL	
Nominal frequency	4,433619	4,433619	3,582056	3,575611	MHz
Bandwidth at −3 dB	3,43 to 5,23	3,43 to 5,23	2,7 to 4,4	2,7 to 4,4	MHz
Phase delay time τ	63,943 ± 0,005	63,943 ± 0,005	63,929 ± 0,005	63,486 ± 0,005	µs µs
Max drift of τ from 10 to 60 °C, relative to 25 °C	5	5	5	5	ns
Spurious signals with respect to 1 τ-signal					
3 τ-signals	⩽ −22	−22*	−22	−22	dB
other reflections	⩽ −30	−35*	−30	−30	dB
Insertion loss ± 3 dB	8	8	8	8	dB
Max input voltage	15	15	15	15	V(p-p)
Storage temperature range	−40 to +70	−40 to +70	−40 to +70	−40 to +70	°C
Termination					
R_1, R_2	390	390	560	560	Ω
reactance X1, X2**	231	231	405	405	Ω
coil adjustment range	−19 to +36	−19 to +36	−20 to +33	−20 to +33	%

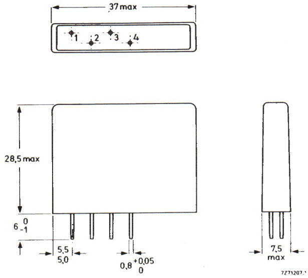


* f = 3,9 to 4,75 MHz

** $X = \frac{\omega_0 L}{1 - \omega_0^2 LC}$



type	DL60	DL61	DL700	DL710	
catalogue no. 4322	027 84600	027 84610	027 84700	027 84710	
status	C	C	N	N	
Application	European PAL	European PAL/SECAM	European PAL	European PAL/SECAM	
Nominal frequency	4,433619	4,433619	4,433619	4,433619	MHz
Bandwidth at −3 dB	3,43 to 5,23	3,43 to 5,23	3,43 to 5,23	3,43 to 5,23	MHz
Phase delay time τ	63,943 ± 0,005	63,943 ± 0,005	63,943 ± 0,005	63,943 ± 0,005	μs μs
Max drift of τ from 10 to 60 °C, relative to 25 °C	5	5	5	5	ns
Spurious signals with respect to 1 τ-signal					
3 τ-signals	⩽ −22	−30*	−22	−30*	dB
other reflections	⩽ −30	−30*	−30	−30*	dB
Insertion loss ± 3 dB	9	9	9	9	dB
Max input voltage	10	10	10	10	V(p-p)
Storage temperature range	−40 to +70	−40 to +70	−40 to +70	−40 to +70	°C
Termination					
R_1, R_2	560	560	390	390	Ω
reactance X1, X2**	350	350	278	278	Ω
coil adjustment range	−19 to +36	−19 to +36	−19 to +36	−19 to +36	%



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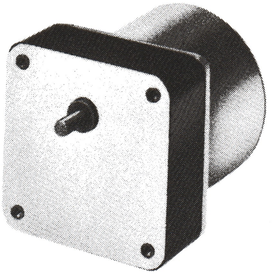
* f = 3,9 to 4,75 MHz

** $$X = \frac{\omega_0 L}{1 - \omega_0^2 LC}$$

electric motors

synchronous motors



Gearbox of 9912 200 000 . . series combined with reversible synchronous motor 9904 111 27 . . .

For detailed information
Handbook CM6

Unidirectional motors – 9904 110 series

An advanced design employing the shaded-pole principle to determine the direction of rotation electrically. All motors in this series are fitted with slide bearings, and their small size makes them ideal for timing applications.

Of special interest are the types 9904 110 06 . . . and 9904 110 09 . . .

These motors are practically inaudible owing to the carefully balanced rotor and precision sintered bronze bearings, which also ensure a long, trouble-free life.

Applications

- control clocks
- central heating clock thermostats
- delay lines
- elapsed time indicators

Gearbox for unidirectional synchronous motors

The 9904 130 01 . . . series of gearboxes has been specifically designed to be combined with all unidirectional synchronous motors (except the 9904 110 09 . . . range). 19 different gear ratios are available.

Reversible motors – 9904 111 series

Constructed with two stator coils, the direction of rotation is governed electrically by the use of an external phasing capacitor. This extremely efficient design allows the motors to operate under high torque conditions as well as in applications where the reversibility of drive is necessary.

Applications

- control valve drive in central heating and air conditioning systems
- industrial programme switches
- paper feed drive in recording instruments
- turn-table drive in record players

Gearbox for reversible motors

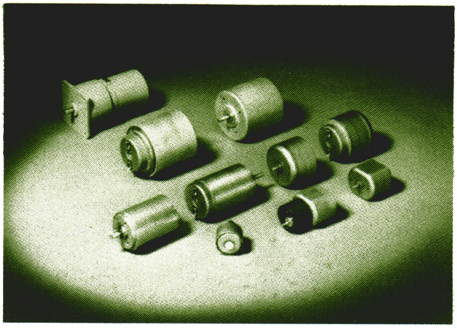
The 9912 200 000 . . series of gearboxes has been designed for use with all reversible motors.

21 different gear ratios are available.

type	voltage V	speed rev/min	torque mNm	dimensions mm	catalogue no.	status
unidirectional; clockwise	220	250	3	ϕ51 x 12	9904 110 02101	D
	220	250	0,5	ϕ35 x 10	05102	D
	220	250	0,25	ϕ35 x 10,5	06102	D
	12	375	0,08	ϕ19,8 x 10,8	09701	D
reversible	220	250	15	ϕ51 x 25	9904 111 04111	C
	220	250	37,5	ϕ44 x 76	06111	D
	220	250	4,5	ϕ35 x 21	07311	D
	220	250	60	ϕ67,5 x 58	27111	N
	220	250	20	ϕ51 x 25	31111	N

Several types are available with different voltage ratings and/or pinion. Counter-clockwise unidirectional motors are also available.

d.c. motors



A versatile range of highly reliable motors covering a wide range of applications

Iron rotor motors

These motors have been designed for use with electronic speed control circuits where the speed of the motor is maintained within narrow limits under wide variations of load and temperature. They are fitted with a 3-pole laminated iron rotor, a gold-plated commutator and a built-in spark suppressor (VDR), the latter increasing the brush life considerably. The construction also includes silver-plated brushes which are damped to ensure low noise and long life. For extremely accurate speed control applications, versions fitted with a frequency tachogenerator are available.
The 9904 120 52 . . . and 53 . . . series feature an integrated gearbox which makes them specially suitable for industrial servo systems.

Applications

- cassette recorders, record players
- dictating machines and telephone answering equipment
- rotating warning lights
- typewriter ribbon drives
- automatic weighing equipment
- film cameras

Ironless rotor motors

These precision-built, low inertia motors feature a quick start/stop performance and smooth running. A gold-plated commutator ensures optimum electronic speed control and long life. The rotor spins around a steel permanent magnet; this yields high efficiency and low current consumption. For the ultimate in accurate speed control, versions fitted with a frequency tachogenerator are available.

Applications

- reel-to-reel recorders
- video long play systems
- video cassette recorders
- digital tape recorders
- computer printers
- computer card readers
- chart recorders

type	voltage V	speed rev/min		torque mNm	dimensions mm	catalogue no.	status
iron rotor	4,3	2000		1	ϕ 34 x 23,6	9904 120 01501	D
	7	2000		1	ϕ 34 x 23,6	01806	D
	7	2000		1	ϕ 34 x 32,7	01809 **	N
	5,2	2000		1,5	ϕ 27,2 x 22,4 x 20,5	03501	N
	12 *	330	motors with reduction	25	ϕ 38,6 x 64	52602	D
	12	60		150	ϕ 38,6 x 64	52605	D
	12	23		150	ϕ 38,6 x 64	52607	D
	12	8,2		150	ϕ 38,6 x 64	52609	D
	3	100		15	ϕ 27,2 x 22,4 x 35,5	53101	D
ironless rotor	12	2815		10	ϕ 40 x 39,6	4322 010 75110	N
	24	2815		10	ϕ 40 x 39,6	75060	N
	24	2815		10	ϕ 40 x 50,5	4322 010 75140 **	D
	16	3000		24	ϕ 40 x 40,6	4322 010 75130	N
	12	3900		5	ϕ 29 x 39,5	9904 120 12601	C
	24	4050		5	ϕ 29 x 39,5	12701	C
	12	3900		5	ϕ 29 x 48,4	12603 **	C
	9	5300		0,3	ϕ 19 x 15	4322 010 77000	N

* 6 V (9904 120 524 . .) and 24 V (9904 120 527 . .) versions available.

** Provided with frequency tachogenerator.

electric motors

stepper motors

Forming the vital link for both advanced electromechanical equipment and also simpler control systems, our range offers a wide selection of versatile stepper motors. Skilfully built our designs have concentrated on precision and reliability, and, together with their drive circuits, serve ideally for both positioning and variable speed applications.

PD series

Professional reversible stepper motors designed for severe environmental conditions and long life. Types are available with step angles of 3¾° (96 steps/rev.) and of 7½° (48 steps/rev.). Fitted with ball bearings which are lubricated for life, these motors are specifically suited for applications where reliability and long life are necessary.

Applications

- optical equipment
- medical equipment
- computer printers
- digital tape recorders
- high-precision drilling machines

ID series

An economic range of reversible stepper motors of simple yet rugged design, suitable for most control instrumentation needs. Ample choice in the ID series from motors with a step angle of 3¾° (96 steps/rev.), 7½° (48 steps/rev.) and 15° (24 steps/rev.).

Applications

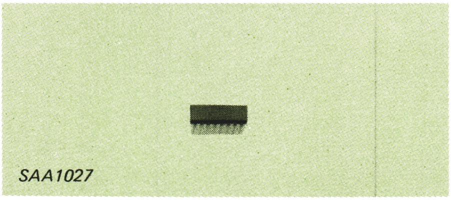
- radar and navigational aids
- slave clock drives
- paper tape readers
- data converters
- infusion pumps

series	steps/rev	max torque mNm	max pull-in rate steps/s	max pull-out rate steps/s	status
PD10	48	7	500	1000	D
PD14	48	25	360	550	D
PD12	96	15	1200	16000	D
PD12B	96	25	1500	25000	D
PD16	96	40	900	7500	D
PD16B	96	75	1150	20000	D
ID07	48	6	500	1000	D
ID04	48	15	350	550	N
ID06	48	50	200	320	D
ID27	48	110	275	275	N
ID27B	48	130	450	5000	N
ID28	24	65	200	250	N
ID28B	24	90	275	3200	N
ID29	96	250	700	6500	N
ID29B	96	280	900	12000	N
ID30	48	165	500	3500	N
ID30B	48	190	520	7000	N
ID31	48	24	400	–	N

Types coded "B" are for bipolar operation: remainder are for operation in the unipolar mode.

4-phase unipolar driver SAA1027

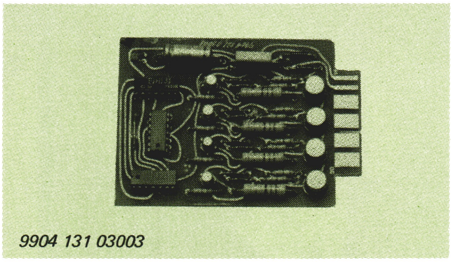
Intended for applications where only "pull-in" operation of the motor is necessary. Comprising 3 input stages, a logic part and 4 output stages, the device is a revolutionary concept in stepper motor drives. This IC will no doubt be a common member of future stepper motor systems.



SAA1027

4-phase unipolar electronic drive unit 9904 131 03003

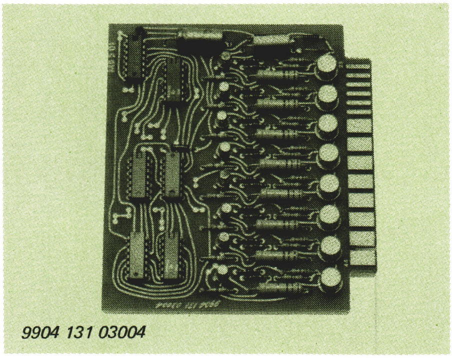
A versatile drive circuit that, combined with the appropriate RC network, is capable of operating the motor up to its maximum "pull-out" rate. The unit runs on a 5 V supply and requires two inputs: the trigger input and the switching sequence. The output stages are equipped with silicon transistors developed for switching inductive loads. All components are mounted on a double-sided printed-circuit board which can be integrated into compact drive systems. The circuit is ideally suited for applications requiring variable speed drives.



9904 131 03003

8-phase unipolar electronic drive unit 9904 131 03004

Designed in a similar manner to the 4-phase unit, this drive provides the required pulse pattern for 8-phase stepper motors. The supply voltage and inputs are the same as the 4-phase unit; the output stages are also equipped with silicon transistors developed for switching inductive loads. Higher speeds are attainable with this 8-phase drive unit than with its 4-phase counterpart.

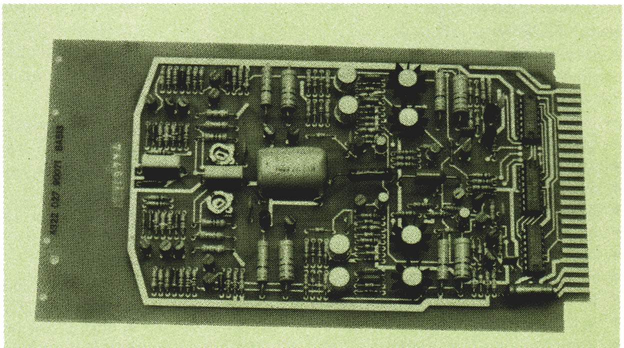


9904 131 03004

Bipolar operation, although more efficient than unipolar, requires additional complex electronics. The bipolar motors driven via the B.C.C.D. switch are intended for applications requiring fast accelerations with short duty cycles as commonly used in rapid positioning systems in computer peripherals.

Bipolar constant current drive unit 4322 027 90070 (B.C.C.D. unit)

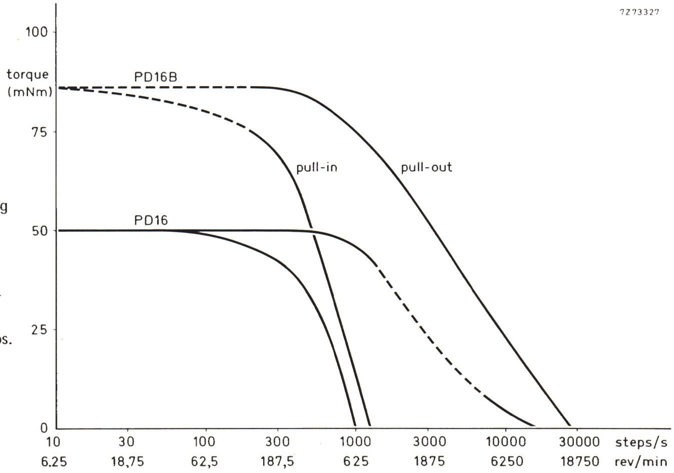
This drive system converts the incoming control pulses into the required current reversals for bipolar operation. The circuit design ensures that the current through the stator coil reaches its maximum value in the shortest possible time, and maintains that value irrespective of opposing currents generated by the rotor. The overall power consumption of this system is relatively low.



4322 027 90070

Advantage of bipolar drive

Bipolar drive allows a considerable increase in the available torque of a motor. This is illustrated below by the torque vs steps/s curves of a PD16 (unipolar mode) and a PD16B (bipolar mode) stepper motor.

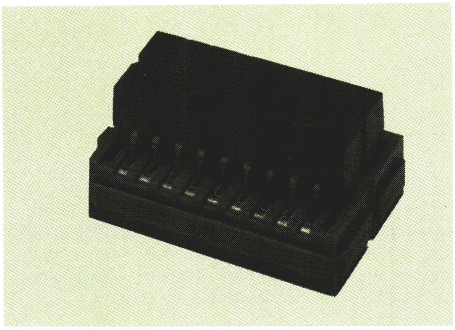


Explanation of terms

Pull-in rate – the maximum switching rate at which a frictionally loaded motor can start without losing steps.

Pull-out rate – the maximum switching rate that a frictionally loaded motor can follow without losing steps.

functional units



Logic
Input/output devices
Mains filters

For detailed information
Handbook CM1

High noise immunity logic
HNIL - FZ/30 series Status D
A comprehensive range of logic elements in 14-16-20 lead plastic dual in-line encapsulations specially designed for low speed digital applications in industrial control, computer periphery equipment and data processing.

- quadruple 2-input NAND gate
- dual 5-input NAND gate
- dual 5-input power NAND gate
- dual AND-AND-OR gate
- quadruple logic interface gate
- dual 4-input NAND gate
- triple 3-input NAND gate
- sextuple inverter with strobe input
- dual 4-input NAND Schmitt trigger
- quadruple 2-input AND gate
- dual NAND gate/quadruple inverter
- quadruple EXCLUSIVE-OR gate
- BCD 7-segment decoder driver
- quadruple NOR gate
- quadruple OR gate
- single JK master-slave flip-flop
- dual JK master-slave flip-flop
- quadruple D-type latch flip-flop
- decimal counter, 4-bit binary counter
- single synchronous 4-bit shift register
- monostable multivibrator
- single BCD-decimal decoder NIT-driver
- dual lamp/relay driver
- timer unit
- short-circuit-proof power stages

Analogue circuit blocks 70 series Status D
These units have been developed to perform basic analogue functions in a wide field of applications such as in the instrumentation field.

- chopper-stabilized operational amplifiers

Accessories for FZ/30, 70, and 60/61/90 series
Comprise printed-circuit boards, stickers, power supply units, empty case assemblies, mounting accessories, flexible printed wiring, breadboard blocks, logic supply units, thyristor trigger transformers, d.c. transformers and logic simulators.

NORbits 60/61/90 series Status D
These units are housed in transfer-moulded encapsulations and can be mounted on printed-circuit boards or by means of a special mounting chassis.

60-series
Based on NOR-logic, these units have been designed for static switching devices for industrial control systems.

- dual 4-input NOR gate
- quadruple 2 x 2 + 2 x 3 input NOR gate
- dual low power amplifier
- dual inverter amplifier
- timer unit
- dual active input switch filter
- power amplifier
- high power amplifier
- grounded load driver

61-series
The units of this series have been designed as an extension to the NORbit range in order to facilitate using NORbits in thyristorized power control circuits.

- universal power amplifier
- dual trigger transformer
- rectifier and synchronization assembly
- dual NOR gate with diode resistor networks

90-series
The trigger logic counterpart of the 60-series; they are intended for counting and shifting.

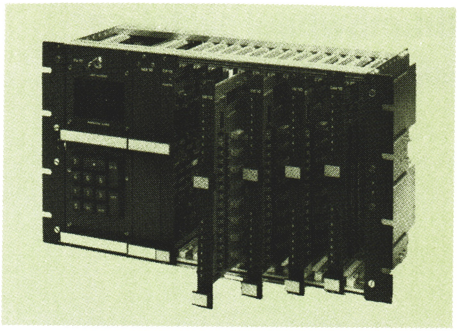
- flip-flop
- twin trigger gate
- pulse shaper

Input/output devices Status D
In this series the following units are available.

- iron vane switched reeds, IVSR
- electronic proximity detectors, EPD, PSD24
- miniature electronic proximity detectors, EPD60
- inductive proximity detectors, IPD080, IPD120, IPD180 IPD185

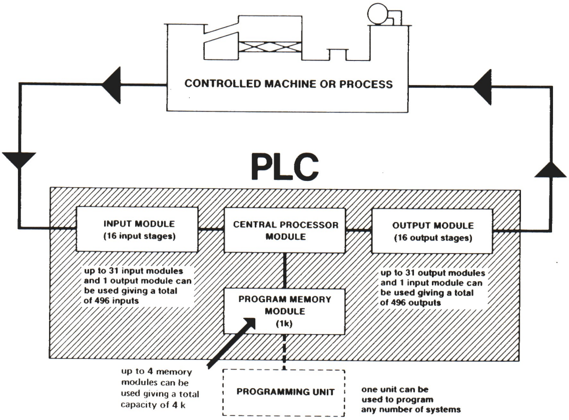
Mains filters Status D
Intended to be used between mains supply connection terminals and the mains input of control systems or between transient generating equipment and its supply. Housed in metal casings, types for 0,5 A and 2,4 A are available.

PLC modules
mosaic printers



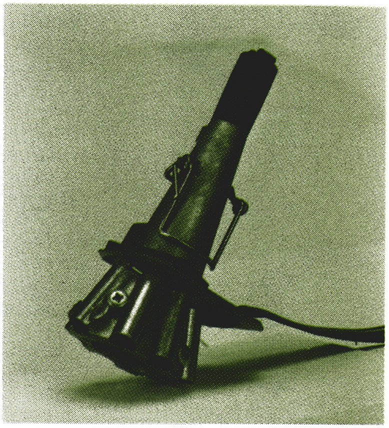
Programmable logic controller modules Status D
With these modules a PLC can be assembled, which is used for industrial controls where the complexity and expense of full computer control cannot be justified.

- input modules, IM10, IM11, LX10
- output modules, OM10, OM12
- memory modules, MM10, MM11, MM12
- central processors, CP10, CP11
- programming units, PU10
- back panels, BP11 to 16
- interface modules, PI10


CONTROLLED MACHINE OR PROCESS
PLC
INPUT MODULE (16 input stages)
CENTRAL PROCESSOR MODULE
OUTPUT MODULE (16 output stages)
up to 31 input modules and 1 output module can be used giving a total of 496 inputs
PROGRAM MEMORY MODULE (1k)
up to 31 output modules and 1 input module can be used giving a total of 496 outputs
up to 4 memory modules can be used giving a total capacity of 4 k
PROGRAMMING UNIT
one unit can be used to program any number of systems

Mosaic printers Status C
These character mosaic printers have been designed as output printing devices for data processing, communication, measuring instrumentation, sales record printing and bank terminals. Alphanumerical characters are formed by means of seven solenoid-operated needles.

60SA/SR
Print on a 60 mm roll; version SA for self-action paper; version SR, which is equipped with an ink-ribbon system, employs normal paper. Printing speed is 60 lines/min of maximum 20 characters/line. Character pattern: matrix, 5 columns of 7 dots.

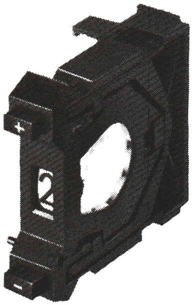


Printer heads
- MPH-1N used in 60SA/SR, 50 characters/second
- MPH-3, 100 characters/second

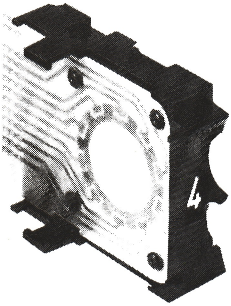
Character modules for 60SA/SR
For drive and control:
- CC64 – character generator for 64 characters
- AC64 – solenoid amplifying device
- CM64 – complete set (AC64 + CC64)

thumbwheel switches

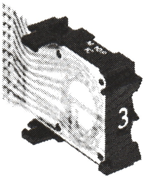
specifications



Type B



Type T



Type M

These quality-engineered switches are designed for use either as preset devices in digital systems handling numerical data, or as positioning switches.

Typical applications include computers, business machines, automatic machine tools, test equipments, process controls, telemetering and utility controls.

Choice of types

This comprehensive range is available in three basic versions:

'T' for direct thumb operation.

'B' with two pushbuttons – just push the 'plus' button to increase or the 'minus' button to decrease.

'M' miniature size for direct thumb operation.

Choice of functions

Decimal switches	– single or double pole
Coding switches	– '1248'
Decoding switches	– '1248' positive logic
Decoding switches	– '1248' negative logic

Specifications

	'T' and 'B' types	'M' type
d.c. working voltage	250 V	250 V
dielectric (for 1 min) d.c.	750 V	750 V
d.c. current switching capacity at 25 °C (resistive circuits)	0,75 A	0,5 A
maximum current carrying capacity	3 A	3 A
contact resistance at 20 mV; 0,1 A; 1 kHz	< 100 mΩ	< 100 mΩ
capacitance at 1 MHz between one terminal and all others connected to earth	1 pF	10 pF
standard gate resistor	6,8 kΩ	6,8 kΩ
operating temperature		
paper epoxy board (with 'N' prefix)	–25 to +70 °C	–25 to +70 °C
glass epoxy board	–55 to +85 °C	–55 to +85 °C
storage temperature		
paper epoxy board (with 'N' prefix)	–40 to +85 °C	–40 to +85 °C
glass epoxy board	–65 to +100 °C	–65 to +100 °C
life (at 1 step/s)	1 000 000 steps	1 000 000 steps
operating torque	35 to 70 mNm	10 to 35 mNm
size of character	8 x 4,5 mm	5 x 3 mm*
line thickness of character	1,1 mm	0,7 mm*
weight approx.	23 g	10 g

* Special 12 position 'M' type has characters as follows:
0 to 9 – 4,0 x 2,4 mm (0,7 mm thick)
10 – 3,8 x 3,1 mm (0,45 mm thick)
11 – 3,8 x 2,2 mm (0,45 mm thick)

survey of types

'N' in front = switch with paper epoxy p.w.b.
'W' in type number = switch with pins for wire wrapping

All types Status D

Multiple switch assemblies – Type 'T'.

Decimal switches

description	'T' type	'B' type	'M' type
10 position, 1 pole, 0 to 9	NT10P1C T10P1C	NB10P1C	NM10P1C M10P1C MW10P1C
10 position, 2 pole, 0 to 9	T10P2C	B10P2C	M10P2C
5 x 2 positions, 1 pole, +–			M5 x 2P1C +– MW5 x 2P1C +–
5 x 2 positions, 2 pole, +–			M5 x 2P2C +– MW5 x 2P2C +–

Coding switches 1248

binary output	NT1248	NB1248	NM1248 NMW1248
binary + complementary output	T1248C	B1248C	M1248C MW1248C
complementary output	NT1248CS	NB1248CS	NM1248CS NMW1248CS

Decoding switches 1248 positive logic

binary output	NT1248P	NB1248P	NM1248P NMW1248P
binary + complementary output	T1248PC	B1248PC	M1248PC MW1248PC
complementary output	NT1248PCS	NB1248PCS	NM1248PCS NMW1248PCS

Decoding switches 1248 negative logic

binary output	NT1248N	NB1248N	NM1248N NMW1248N
binary + complementary output	T1248NC	B1248NC	M1248NC MW1248NC
complementary output	NT1248NCS	NB1248NCS	NM1248NCS NMW1248NCS

Accessories	switch type
set of two end pieces with screws	T, B, M
set of two end pieces with brackets	T, M
spacer	T, M
spacer without rib	T
spacer with decimal point	M

Special versions

Internally lit switches

White translucent rotor with black engraving. Lamp max. 5 V. Minimum life time 50 000 h (about 6 years). Lower voltage (applicable in dark room) extends the life time. Type number prefix is extended with an 'L', for example, LNM1248.

Wire wrapping

'M' types with pins for wire wrapping can be supplied ex stock as listed. 'T' and 'B' types with pins for wire wrapping can be supplied on request. The number is then the same as shown in the table but with the letter 'W' inserted behind the 'T' or 'B'; for example, TW1248C.

Limit stops

Rotation of the rotor can be limited to any position by means of stop pins.
for 'T' switches these are self-tapping screws, diameter 2,18 mm, length 4,8 mm, which can be removed.
for 'B' and 'M' switches these are specially tooled parts. They can be fitted by means of a pair of tweezers and cannot be removed.
The stop pins can be installed by customer or by factory. Minimum quantities 1000 pieces.

Sealed switches

Contact chamber is sealed by an elastomer ring, for protection against dust and sand. May be used in explosive and aggressive atmospheres. Type number is prefixed with an 'S'; for example, SNT1248.

Colour of housing/rotor

Rotor is available in red. Type number is prefixed with an 'R'; for example, RNT1248.
Other colours for rotor and housing can be considered, but only for order quantities in one batch and one colour of 10 000 pieces or more.

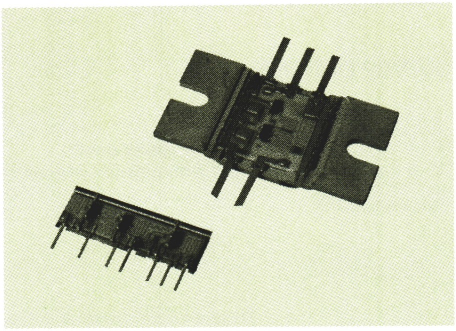
Special engraving

Special engraving requirements can be undertaken. Due to cost of specific tooling, a minimum quantity of 5000 is recommended.

Twelve position miniature switches

All miniature switches can also be supplied with twelve positions on request. The symbols on the rotor are then smaller – see 'Specifications' page C178; the size of housing and window do not change.

hybrid circuits



Wide-band amplifiers Status D

Intended for use in RATV, MATV and CATV systems and for general purposes in v.h.f. and u.h.f. applications.

For detailed information
Handbook CM1

Typical characteristics

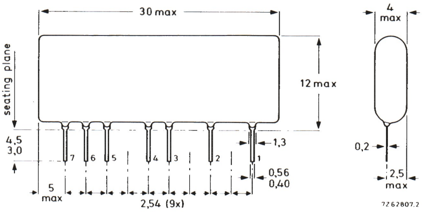
type	gain $|s_{fl}|^2$ dB	V_o(r.m.s.)* dBμV	supply current mA	noise figure dB	VSWR typical max values in	VSWR typical max values out
OM320	15,5	92	23	5,5	2,2	2,5
OM321	15,5	98	33	6	2,5	2
OM322	15	103	60	7	1,7	1,7
OM323	15	113	100	9	1,9	2,3
OM335	27	98	35	5,5	1,9	3,2
OM336	22	105	65	7	1,4	1,6
OM337	26	112	115	9,8	2,3	1,8

* Minimum output voltage at –60 dB intermodulation distortion (DIN 45004, 3-tone, f = 470 MHz).

All amplifiers:

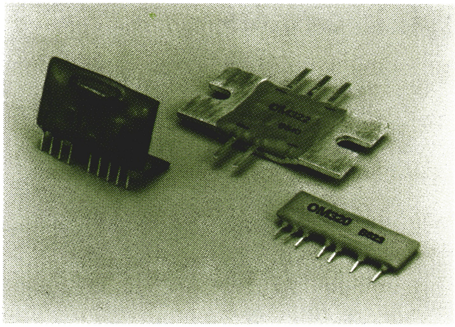
frequency range	f	40 to 860 MHz
source and load (characteristic) impedance	$R_s = R_l = Z_o$	75 Ω
supply voltage (d.c.)	V_B	24 V ± 10%
operating ambient temperature	T_{amb}	–20 to +70 °C
pinning (except OM322)	suitable for 0,1-inch grid	
finish	resin coated	

Encapsulations
OM320
OM321
OM335



Terminal connections

1	= input
2, 3, 5, 6	= common
4	= supply (+)
7	= output

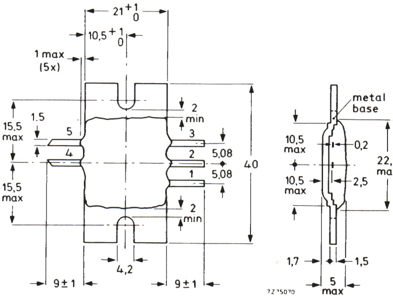


OM322
OM320

OM322

Terminal connections

1 = supply (+)
2 = input
3 and 5 = common (internally connected to metal base)
4 = output

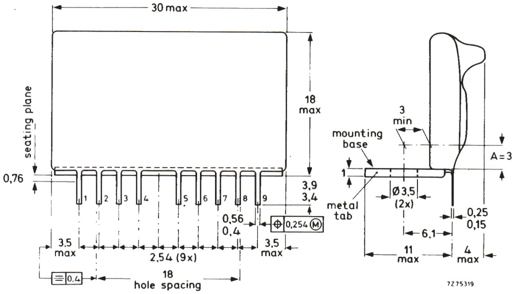


21 +1 0
10,5 +1 0
1 max (5x)
1,5
15,5 max
15,5 max
5
4
2 min
3
2
1
5,08
5,08
40
2 min
4,2
9 ± 1
9 ± 1
metal base
10,5 max
10,5 max
0,2
22,8 max
2,5
1,7
1,5
5 max
7Z75070

OM323
OM337

Terminal connections

1 = input
2, 3, 5, 6, 7, 8 = common, connected to mounting tab
4 = supply (+)
9 = output

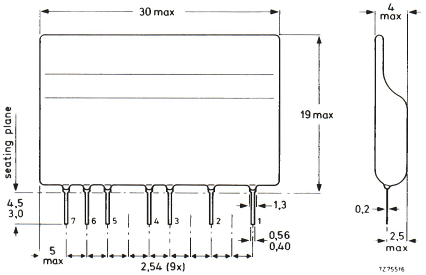


30 max
seating plane
18 max
0,76
1
2
3
4
5
6
7
8
9
3,9
3,4
0,56
0,4
0,254 M
3,5 max
2,54 (9x)
3,5 max
0.4
18 hole spacing
3 min
mounting base
A = 3
1
metal tab
Ø3,5 (2x)
0,25
0,15
6,1
11 max
4 max
7Z75319

OM336

Terminal connections

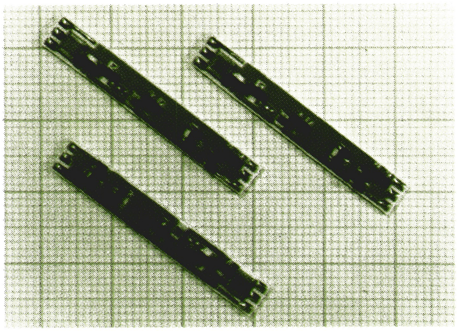
1 = input
2, 3, 5, 6 = common
4 = supply (+)
7 = output



30 max
seating plane
19 max
4,5
3,0
7
6
5
4
3
2
1
1,3
0,56
0,40
5 max
2,54 (9x)
4 max
0,2
2,5 max
7Z75516

hybrid circuits

Inductive proximity switches



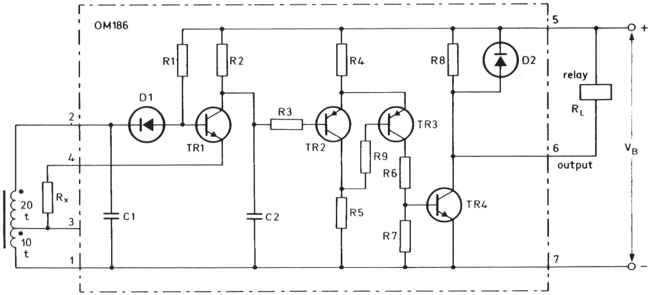
Unpotted modules for proximity switches in tubular construction. OM186 for positive supply voltage, OM187 for negative supply voltage. The circuit consists of an oscillator, a rectifier stage, a level switch and an output stage. The coil is not incorporated in the hybrid circuit.

Thick film ceramic substrate, oscillator coil and adjustment resistor R_X may be potted in a non-magnetic tube.

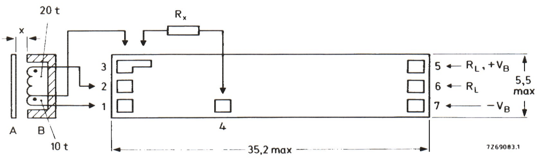
Dimensions of substrate are suitable for mounting in a standardized ϕ 8 mm tube (Cenelec).

Supply voltage	V_B		4,5 to 30	V
Load resistance	R_L	min	120	Ω
Switching distance (V_B=24V; potcore 5,8 mm)				
R_X = 330 Ω	x	typ	1,5	mm
Hysteresis of switching distance	Δx		3 to 10	%
Switching frequency	f	<	5	kHz
Operating ambient temperature (potted)	T_{amb}		−25 to +65	°C

Circuit diagram


OM186
R1
R2
R3
R4
R5
R6
R7
R8
R9
D1
D2
TR1
TR2
TR3
TR4
C1
C2
Rx
20 t
10 t
1
2
3
4
5
6
7
+
−
relay
RL
output
VB
7Z69082.1

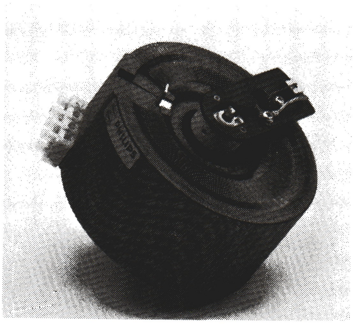
The OM187 circuit is similar to the OM186 with all polarities (transistors, diodes and supply) reversed.


20 t
x
Rx
A
B
10 t
1
2
3
4
5
6
7
RL, +VB
RL
−VB
5,5 max
35,2 max
7Z69083.1

A = metallic object.

B = open potcore or potcore half with coil.

variable mains transformers



For detailed information
Handbook CM8

Variable mains transformers

Applications:

- distortion-free voltage control for measuring equipment, voltage stabilizers, etc.
- power control for electric heating, heat sealing of plastics, motor speed
- current control for galvanising plants
- light control in hotels, cinemas, homes, etc.
- ventilation control in buildings, livestock houses, greenhouses, etc.

Features:

- continuous voltage control
- small dimensions and high efficiency
- very low stray losses
- corrosion resistant
- long life
- simple servicing
- ganging possibilities
- adjustable spindle length
- low coil resistance
- high overload characteristics

Our range comprises bench and panel mounting versions.

- standard types: input voltages from 42 to 276 V, frequency range 50-400 Hz; output voltages 0 to 276 V, output current 0,25 to 23 A
- transformers with separate windings: input voltage 220 V, frequency range 50-60 Hz; output voltage 0-242 V, output current 3 A

Accessories

- ganging units: 2 or 3 transformers on one shaft, connected in series, parallel, star or open delta circuit
- motor drive modules: revolutions from 6 s to 1 h, complete with gearbox, motor, phasing capacitor, switch set and ganging unit
- control knobs with dial calibration 0-100%, 0-115%, 0-260 V, 0-270 V
- chokes for parallel mounting
- A.C. stabilizer module: input voltage $220\ \mathrm{V}^{+10\%}_{-15\%}$; output voltage 5-115% of input voltage, stabilized

connectors

Originally designed to satisfy the severest requirements of our own professional equipment, our present range covers a wide field where good, reliable connectors are a must. Contact spring design and body material choice is based on international standards, thus resulting in real professional products, meeting IEC and military standards.

For detailed information
Handbook CM10

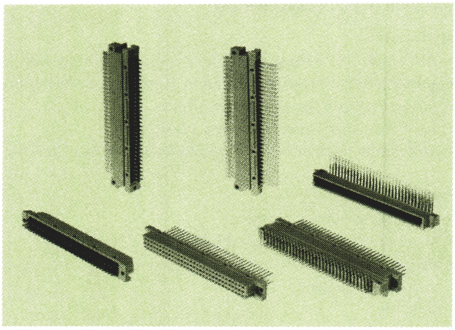
Applications
- telecommunication
- data processing
- instrumentation and control

Body materials
- phenol
- diallylphthalate
- polyester
- polycarbonate
- phenolphormaldehyde
- thermoplastic

Contact material, pins and springs
- phosphor bronze or brass, gold surfaced

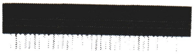
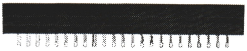
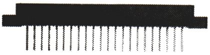
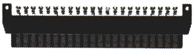
Contact terminations
- solder tags
- dip-solder pins, straight and 90° angled
- pins for wire-wrapping
- pins for mini wire-wrapping
- crimp

Types
- printed-wiring connectors (female) for chassis or panel mounting, fixed length or length to choice; pitches 2,54–3,81–3,96 and 5,08 mm (0,1–0,15–0,156 and 0,2 inch)
- two-part connectors, for board to panel or chassis, fixed length; pitches 2,54–3,81–5,08 mm (0,1–0,15–0,2 inch)
- interconnectors (male), for board mounting, fixed length; pitch 3,96 mm (0,156 inch)
- jumper connectors, used as jumper or permanent link between circuit parts, female with two sockets, pins loose or on strip; pitch 2,54 mm (0,1 inch)
- modular connector system, interconnecting electronic functions (modules) either vertically or in stacks, length to choice; pitch 2,54 mm (0,1 inch)
- subminiature rack and panel connectors developed to meet dimensional standards of MIL-STD-C-24308
- various mounting accessories
- crimp tools: stripper-crimper, pneumatic crimp machine, hand crimp tools



Examples of F068-I connectors.

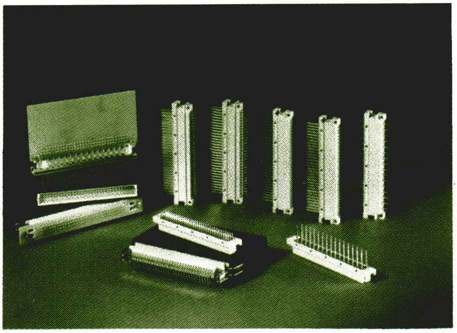
printed-wiring connectors and interconnectors

	type number	pitch mm (in)	number of contacts	terminations	current at 20 °C A	mechanical endurance insertions
Printed-wiring connectors						
	**F044**	2,54 (0,1)	4 to 39 (bridged)	solder tags or dip-solder pins	3	300
	**F045**	5,08 (0,2)	1 to 54 (single row) 2 to 108 (double row)	solder tags	4,5	300
	F046	3,81 (0,15)	4 to 45 (single row) 8 to 90 (double row)	solder tags	4,5	300
	F047	3,96 (0,156)	6,10,15,18,22 (single row) 12,20,30,36,44 (double row) 6,10,15,18,22 (bridged)	solder tags	5,5	250
	F050	3,96 (0,156)	6,10,15,18,22 (single row) 12,20,30,36,44 (double row) 6,10,15,18,22 (bridged)	solder tags	5,5	100
	**F053**	3,96 (0,156)	6,10,15,18,22,28,36,43 (single row) 12,20,30,36,44,56,72,86 (double row)	dip-solder pins or pins for wire-wrapping	4	250
Printed-wiring interconnectors						
	**F051**	3,96 (0,156)	6,10,15,18,22 (single row) 12,20,30,36,44 (double row)	solder tags	5,5	300

connectors

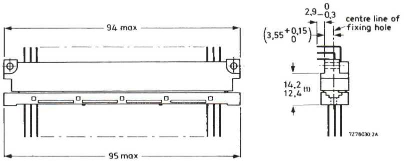
F 068-I – 2,54 mm; 2 A at 20 °C

Eurocard
two-part printed wiring connectors
to IEC 130-14, DIN 41612, VG 95324



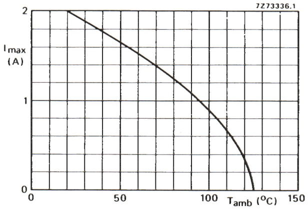
Contact pitch and number of contacts		
style B (2 rows)	2,54 mm (0,1 in)	32 or 64
style C (3 rows)	2,54 mm (0,1 in)	64 or 96
	5,08 mm (0,2 in)	32
Board thickness	1,42 to 1,78 mm	
Terminations male part	90° angled dip-solder pins* straight dip-solder pins* solder tags 90° angled pins for wire wrapping	
Terminations female part	pins for wire wrapping straight dip-solder pins solder tags 90° angled dip-solder pins	
Current at T_{amb} = 20 °C	2 A	
Mechanical endurance		
to IEC and DIN	400 insertions	
to VG	500 insertions	
Climatic category IEC 68	55/125/56	

* Male part dip-solder pins are also available with protruding earth contacts.



(1) reliable contact range

Combination of connector parts.



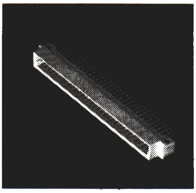
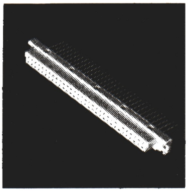
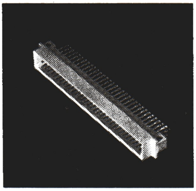
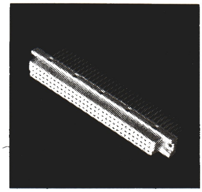
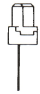
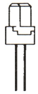
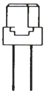
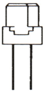
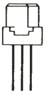
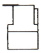
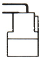
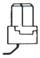
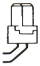
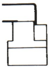
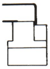
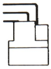
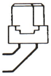
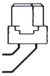
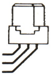
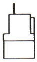
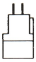
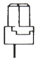
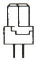
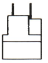
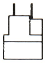
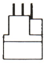
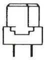
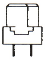
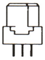
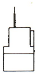
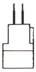
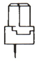
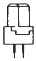
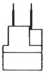
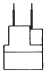
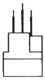
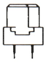
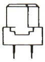
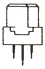
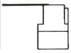
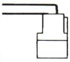
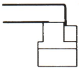
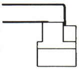
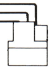
Maximum current per contact, equally on all contacts, as a function of ambient temperature (20% derated).

These connectors are designed for use in applications where high quality and high density packaging of electronic circuits are required. They can be used on single Eurocards (100 mm x 160 mm), double Eurocards (233,3 mm x 160 mm) and 19-in racks according to DIN 41494.

The connectors consist of a male part to be fitted to a printed-wiring board and a female part to be mounted on a chassis or a back panel. Both parts have a grey body of glass-fibre-filled thermoplastic material; the contact insert of the female part is of glass-fibre-filled diallylphthalate. The contact springs of the female part are of phosphor bronze; the contact pins of the male part are of brass; the contact surfaces are gold on nickel plating. The contact terminations of both parts are gold flashed. The male parts with dip-solder pins can be supplied with protruding earth contacts, which are approximately 1 mm longer than the other contacts. No special provisions are required for polarization. Cable hoods, locking clips and brackets are available for various applications. An external keying system can be employed to ensure correct positioning of the board in a rack.

Accessories
- ○ cable hoods and associated parts
- ○ receptacle for attaching female connector to the pins for wire-wrapping of another female connector
- ○ coding system
- ○ mounting brackets for fitting female connector with 90° dip-solder pins to edge of PCB
- ○ various locking parts

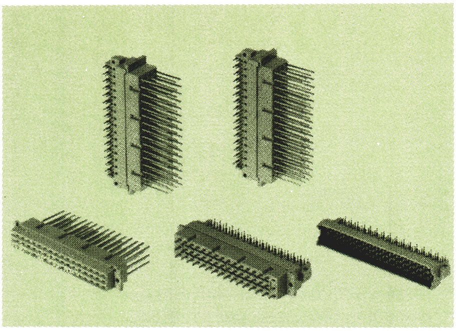
★ available with protruding earth contacts
▲ available to German mil spec VG 95324

	Style B (2-row body)				**Style C** (3-row body)					
	Male		Female		Male			Female		
										
number of contacts	1 x 32	2 x 32	1 x 32	2 x 32	2 x 16*	2 x 32	3 x 32	2 x 16*	2 x 32	3 x 32
pitch (mm)	2,54	2,54	2,54	2,54	5,08	2,54	2,54	5,08	2,54	2,54
row spacing (mm)	–	2,54	–	2,54	5,08	5,08	2,54	5,08	5,08	2,54
					* even numbered pins only			* even numbered pins only		
straight pins for wire-wrapping				▲ 						▲ 
90° dip-solder pins	★ 	★▲ 			★ 	★ 	★▲ 			
straight dip-solder pins	★ 	★ 			★ 	★ 	★ 			
solder tags										
90° pins for wire-wrapping										

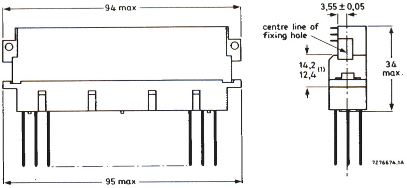
connectors

F 068-II – 5,08 mm; 5,5 A at 20 °C

Eurocard
two-part printed wiring connectors
to IEC 130-1 and DIN 41612

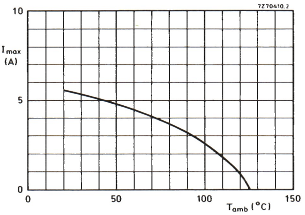


Contact pitch and number of contacts		
style F	5,08 mm (0,2 in)	32 or 48
style G	5,08 mm (0,2 in)	64
Board thickness	1,42 to 1,78 mm	
Terminations male part	90 ° angled dip-solder pins	
Terminations female part	straight dip-solder pins (style F only) pins for wire wrapping	
Current at T_{amb} = 20 °C	5,5 A	
Mechanical endurance	400 insertions	
Climatic category IEC 68	55/125/56	



(1) reliable contact range

Combination of connector parts.



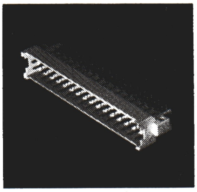
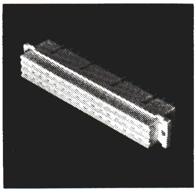
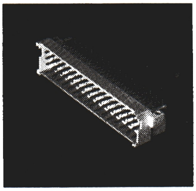
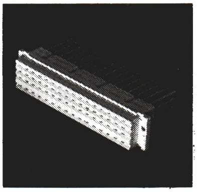
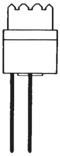
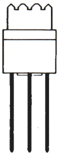
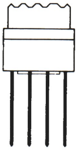
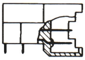
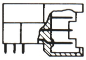
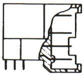
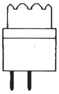
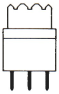
Maximum current per contact, equally on all contacts, as a function of ambient temperature (20% derated).

For use in applications where high current and/or high voltage operation is required. For signal connections the complementary F068-I series of connectors can be employed. The combination of F068-I and F068-II connectors is ideal for a wide range of professional applications, including those having severe industrial environments.

The connectors consist of a male part to be fitted to a printed-wiring board and a female part to be mounted on a chassis or a back panel. Both parts have a grey body of glass-fibre-filled thermoplastic material.
The contact springs of the female part are of phosphor bronze, the contact pins of the male part are of brass; the contact surfaces are gold on nickel plating. The contact terminations of both parts are tinned. The contact springs of the female part are reinforced with a steel spring, which gives an extra guarantee for reliable functioning under severe conditions of continuous load, vibration, etc. Female parts with non-reinforced springs are also available. The male parts are supplied with protruding earth contacts, which are approx. 1,5 mm longer than the other contacts. Removal of contacts from the male part can be done by means of a tool.
No special provisions are required for polarization.

Accessories
- ○ tool for removing pins from male connectors
- ○ tine resetting tool

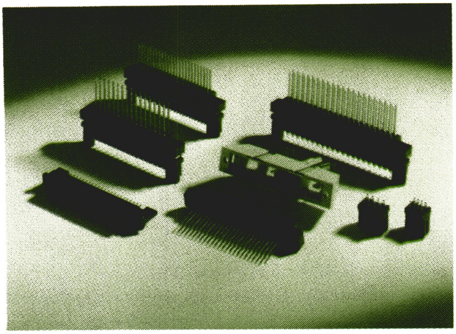
all connectors use even numbered pins only.
all male connectors available with protruding earth contacts.
all female connectors available with reinforced contacts.

	Style F (3-row body)				**Style G** (4-row body)	
	Male		Female		Male	Female
						
number of contacts	2 x 16	3 x 16	2 x 16	3 x 16	4 x 16	4 x 16
pitch (mm)	5,08	5,08	5,08	5,08	5,08	5,08
row spacing (mm)	5,08	5,08	5,08	5,08	5,08	5,08
straight pins for wire-wrapping						
90° dip-solder pins						
straight dip-solder pins						

connectors

F080 — 3,81 mm; 2,5 A at 20 °C
F081 — 2,54 mm; 2 A at 20 °C

two-part printed wiring connectors
long-life

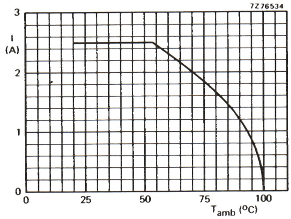


	F080	**F081**
Contact pitch	3,81 mm (0,15 inch)	2,54 mm (0,1 inch)
Number of contacts, double row	32, 42	48, 64
test plug, double row	8	8
Board thickness	1,42 to 1,78 mm	1,42 to 1,78 mm
Terminations male part	pins for wire-wrapping	pins for wire-wrapping
Terminations female part	solder tags	solder tags or solder tags with eyelet (only for 48 contacts)
Terminations test plug	solder tags with eyelet	solder tags with eyelet
Current at T_{amb} = 20 °C	2,5 A	2 A
Mechanical endurance	500 insertions	500 insertions
Climatic category IEC 68	10/070/21	10/070/21

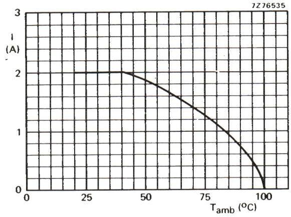
Long-life PCCs
These PC connectors were specially developed to meet the ultra-high reliability standards of telecommunications authorities, for which Philips is a major system supplier. Such standards involve a minimum of 500 insertions while retaining a gas-tight contact, which is approx. equivalent to a 25-year service life. At the same time these particular connectors, the F080/81 series, were specified with narrow tolerance dimensions in order to allow at least three PCCs to be mounted along one edge. As well as setting demanding specifications, telecommunications authorities are also big connector users. The F080/81 series are therefore proof of our ability to produce customized connectors in volume, as well as to high quality standards. For both types a test plug is available in order to monitor circuit parameters.

The connector bodies are formed from dark green glass fibre/phenolformaldehyde. The contact springs and pins are of phosphor bronze with a 2,5 μm gold plating (min) over 2,0 μm of nickel. Contact mating length is along 3,5 mm.

F080



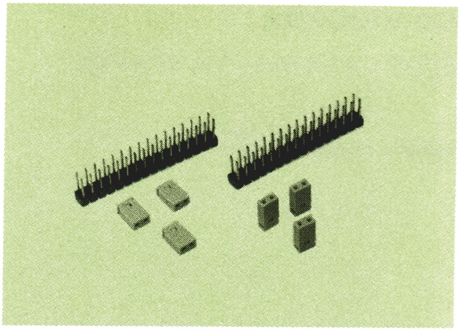
F081



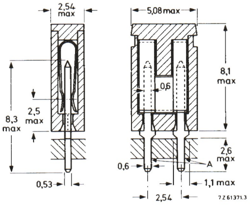
Maximum current per contact, equally on all contacts, as a function of ambient temperature (derated 20%).

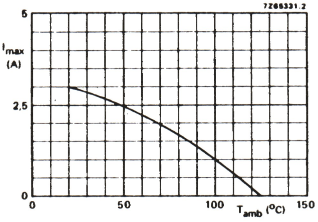
F088 – 2,54 mm; 3 A at 20 °C

two-part jumper connector



Contact pitch	2,54 mm (0,1 in)
Number of contacts	2
Board thickness	1,42 to 1,78 mm
Terminations	dip-solder pins
Current at T_{amb} = 20 °C	3 A
Mechanical endurance	150 insertions
Climatic category IEC 68	55/125/21





Maximum current per contact, equally on all contacts, as a function of ambient temperature (20% derated).

The connector consists of two contact pins for dip-solder mounting and a female plug. The plug is moulded in grey glass-fibre-filled thermoplastic. The contact springs in the plug and the pins are of phosphor bronze, the springs are shaped to provide two contact surfaces.

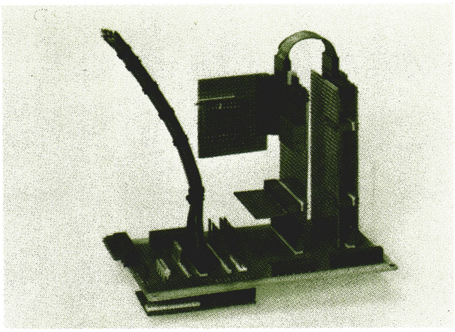
The contact faces are hard gold plated. The pins can be supplied either loose or in a mounting strip with 2 x 16 pins which can be removed after dip soldering.

If the contact pins are to be permanently interconnected, a modified wire wrapping can be used instead of the female plug.

connectors

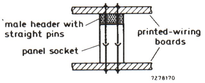
F095 – 2,54 mm; 3 A at 20 °C

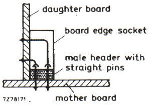
modular connector system

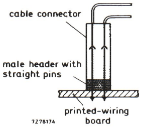


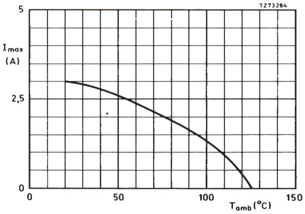
Contact pitch	2,54 mm (0,1 in)
Number of contacts	
Female connectors	
board edge socket, single and double row	2 to 130
panel socket, single and double row	2 to 100
cable connector, double row	4 to 64
Male connectors	
male header, straight pins, single and double row	2 to 64
mounting block for pins, double row	8, 12, 20
male header, 90° angled pins, single and double row	15 to 30
Board thickness	1,42 to 1,78 mm
Terminations	dip-solder pins
	pins for wire-wrapping
	crimp contacts
Current at $T_{amb} = 20\ ^\circ C$	3 A
Mechanical endurance	300 insertions
Climatic category IEC 68	55/125/21

Examples of F095 connectors









Maximum current per contact, equally on all contacts, as a function of ambient temperature (20% derated).

This modular connector system has been developed to provide a simple, flexible yet reliable means of interconnecting electronic circuit boards and modules in applications where maximum packing density is of major importance.

The system consists of the following parts (see examples).
Female connectors:
- board edge sockets for connecting daughter boards at right angles to mother boards in vertically stacked card systems;
- panel sockets for horizontally stacking printed-wiring boards;
- cable connectors for connecting cable forms to printed-wiring boards or for making multi-way jumper cables.

Male connectors:
- male headers with straight or 90° angled pins for accommodating mini wire wrapping joints or mating panel sockets and board edge sockets;
- mounting block for pins, which can be removed after mounting if required.

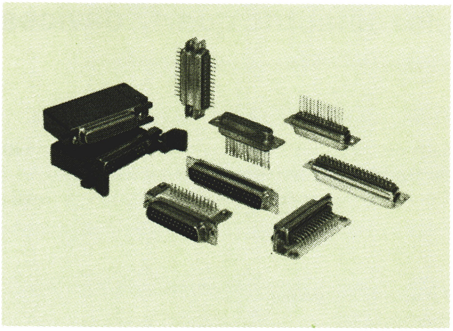
The board edge sockets, panel sockets and cable connectors have a body of flame retardent, glass-fibre-filled thermosetting material. The sockets are provided with pins for dip or wave soldering. The cable connectors contain a number of holes allowing crimpable contact springs to be inserted into the body. These crimp-on snap-in contact springs are supplied loose or on reels.

The male headers and the mounting blocks have a body of flame retardent, glass-fibre-filled thermoplastic polyester material. They are provided with dip-solder pins or pins for wire wrapping.

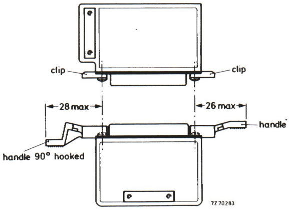
The contact springs and pins are of gold finished phosphor bronze; the electrical contact surfaces are gold on nickel plating.

F161 – 7,5 A at 20 °C

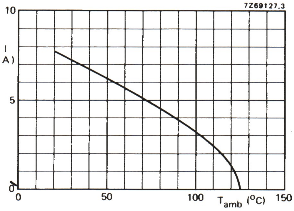
subminiature rack and panel connectors



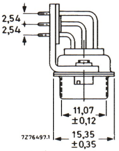
Number of contacts	9, 15, 25, 37 and 50
Terminations	solder cups dip-solder pins, straight or 90° angled pins for wire wrapping crimp-on snap-in
Current at T_{amb} = 20 °C	7,5 A
Mechanical endurance	500 insertions
Climatic category IEC 68	55/125/21
Dimensions	according to MIL-STD-C-24308



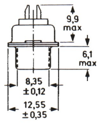
Cable hood and locking device.



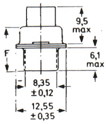
Maximum current per contact, equally on all contacts, as a function of ambient temperature (20% derated).



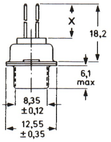
90° dip-solder



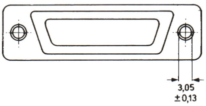
solder cup

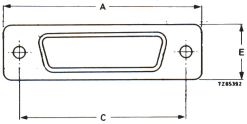


crimp



wire wrapping dip-solder





Dimensions in mm (P = pin; S = socket)

number of connections	A ±0,35	C ±0,12	E ±0,35	F ±0,25
9(P)	30,8	25,0	12,55	10,7
9(S)	30,8	25,0	12,55	10,9
15(P)	39,15	33,3	12,55	10,7
15(S)	39,15	33,3	12,55	10,9
25(P)	53,0	47,05	12,55	10,7
25(S)	53,0	47,05	12,55	10,9
37(P)	69,3	63,5	12,55	10,7
37(S)	69,3	63,5	12,55	10,9
50(P)	66,9	61,1	15,35	10,7
50(S)	66,9	61,1	15,35	10,9

X = 6 mm for dip-soldering
X = 12,7 mm for wire wrapping

For rack and panel connection in industrial, telecommunication and data processing equipment.

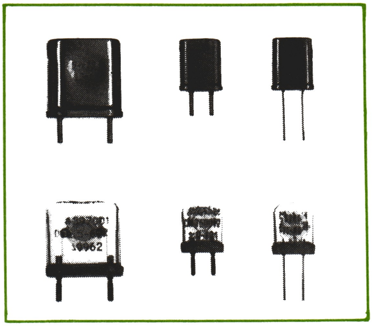
The connectors consist of a red glass-fibre polycarbonate insulating block, mounted in a shell of passivated, cadmium-plated steel. The insulating block contains a number of contact pins or sockets, which are made of a copper alloy and are gold plated on a nickel layer.

Different types of pin and socket terminations are available: for hand or dip-solder, wire wrapping or crimp applications. For the latter application the contact pins and sockets are supplied as loose parts, while the insulating block of the connector contains only a number of holes allowing the crimpable pins and sockets to be loaded into the block. The contacts can be crimped with MIL-standardized tools.

The connectors meet the dimensional requirements of MIL-STD-C-24308.

If a connector is to be used as a cable plug or socket, it can be fitted with a cable hood and locking device.

piezoelectric quartz devices



Each device consists of a quartz crystal element with electrodes, mounted in a glass or metal holder.
The AT-cut types cover the frequency ranges listed below.

For detailed information
Handbook CM9

Quartz crystals for professional applications – high precision

• fundamental frequencies	1,8 to 20 MHz
• third overtone	10 to 61 MHz
• fifth overtone	50 to 110 MHz

Available in either glass or metal holders, the latter being either solder sealed or resistance welded. They provide stable frequencies under severe temperature conditions, as in oscillator circuits in communication equipment, for example.

Test methods:
passive network (IEC – π network)
crystal test set TS-193A (British military standard)
crystal impedance meter TS-330/TSM (U.S. Army standard)
crystal impedance meter TS-683/TSM (U.S. Army standard)

Quartz crystals for special applications

• colour television; e.g.	4433,619 kHz 8867,238 kHz
• television tuning	4000,000 kHz
• clock; e.g.	4194,304 kHz 4194,812 kHz
• teletext	6000,000 kHz
• two-tone dialing	4782,720 kHz

Available in resistance welded metal holder.

• high precision	10 MHz

Available in all-glass holder HC-27U

Temperature compensated crystal oscillators (TCXO)

Frequency range	4,5 to 15 MHz 20 to 50 MHz frequency adjustable with external trimmer frequency tolerance ± 2 x 10^{-6}
Temperature range	–20 to +70 °C

These modules comprise a quartz crystal oscillator and a thermally controlled circuit to compensate frequency changes over the whole temperature range. The hermetically sealed metal housing is filled with dry nitrogen.
TCXOs find application in synthesizers, instrumentation, electronic timing devices, mobilophones, etc.

How to specify when ordering

1. **nominal** frequency in kHz
2. mode of vibration
3. accuracy of adjustment ... x 10^{-6}
4. frequency drift over temperature range ... x 10^{-6}
5. temperature range ... °C
6. series resonance or load capacitance in parallel or in series with unit ... pF
7. type of holder

permanent magnet materials

For detailed information
Handbook CM4b

Ferroxdure and Ticonal are among the most advanced permanent magnet materials available today. Magnets are made from these materials in a vast range of shapes and sizes, and the cost/weight/performance factor is excellent. Properly used, the strength of these magnets will remain practically unchanged throughout an indefinite lifetime. They are used mostly to transduce energy from one form to another, or to exert a force. This catalogue contains only a small selection of what is already being done: much more is possible.

energy transduction

- **Electrical/mechanical**: in motors, meters, loudspeakers, beam deflectors, mass spectrometers
- **Mechanical/electrical**: in generators, alternators, dynamos, microphones, pick-ups
- **Mechanical/heat**: in hysteresis/torque and eddy-current instruments

force exertion

- **On a magnetic material**: in attraction, repulsion, holding, lifting
- **On a moving electrical charge**: in magnetrons, klystrons, image intensifiers

materials and shapes

- **Anisotropic ceramic Ferroxdure**
  segments: in motors, magnetos
  rings: in loudspeakers
  discs and blocks: in metal separators, chucks, clamping plates

- **Isotropic ceramic Ferroxdure**
  segments: in small d.c. motors
  rings: in synchronous motors, alternators, dynamos
  blocks: in microphones, telephones, pick-ups, watches, reed switches
  tubes and rods: in tv convergence units, linearity controls

- **Anisotropic plastic-bonded Ferroxdure**
  strips: in latches, refrigerator doors

- **Isotropic plastic-bonded Ferroxdure**
  rings and segments: in tv linearity controls

- **Anisotropic metal alloy Ticonal**
  rods, rings, discs, blocks and slugs: in watches, loudspeakers, microphones, telephones, meters, magnetos, motors, eddy-current brakes

permanent magnet materials

survey of material grades – S.I. units

The term typical value ("typ") denotes a value which frequently occurs; it is not intended to be an average or mean value. Typical values enable the user to compare various grades.

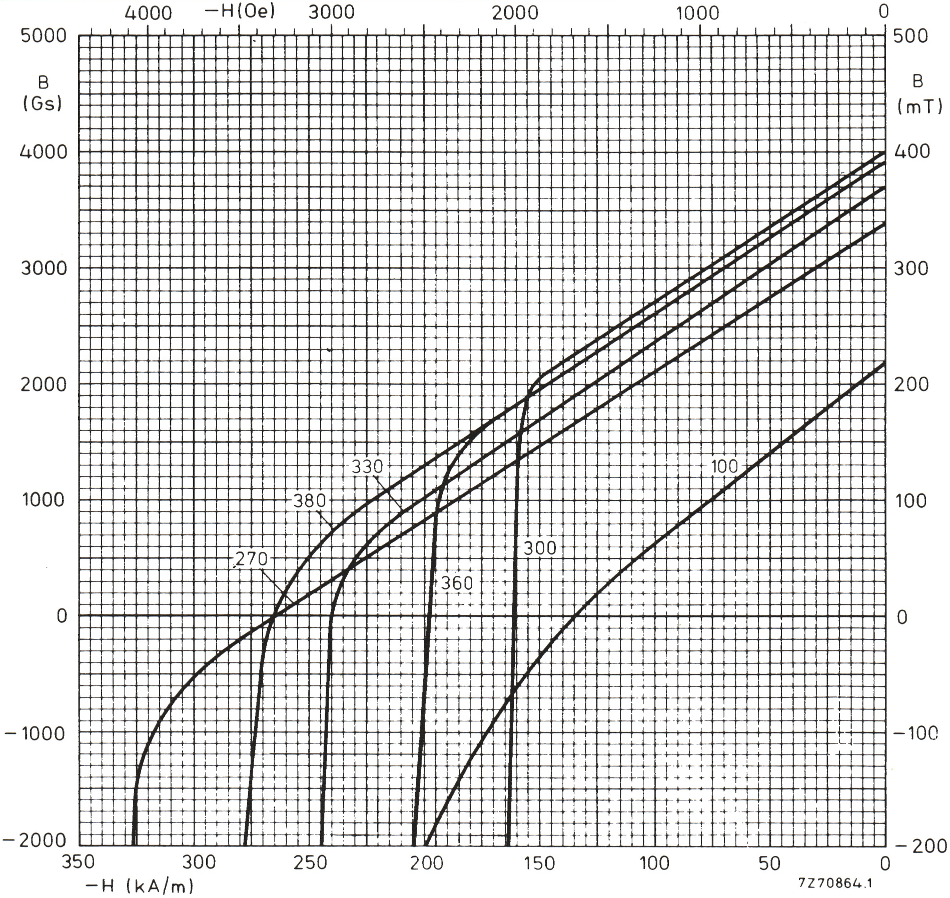
	max BH product		remanence		coercivity		polarization coercivity		B and H at $(BH)_{max}$		saturation field strength
	$(BH)_{max}$ (kJ/m³)		B_r (mT)		H_{cB} (kA/m)		H_{cJ} (kA/m)		B_d(mT)	H_d(kA/m)	H_{sat}(kA/m)
	typ	min	typ	min	typ	min	typ	min	typ	typ	
Anisotropic ceramic Ferroxdure, $SrFe_{12}O_{19}$, (Ferroxdure 300: $BaFe_{12}O_{19}$) Magnets are pressed and sintered and may be ground.											
FXD 270	21,5	19,9	340	330	263	247	334	318	165	131	min 1114
FXD 330	25,5	23,9	370	360	239	223	247	231	180	143	min 876
FXD 360	28,7	27,1	390	380	199	183	207	191	200	143	min 716
FXD 380	27,8	26,2	390	380	263	247	279	263	188	148	min 955
FXD 300	29,5	27,8	400	390	159	143	163	147	240	123	min 557
Isotropic ceramic Ferroxdure, $BaFe_{12}O_{19}$ Magnets are pressed or extruded, sintered and may be ground.											
FXD 100	7,6	7,2	220	210	135	130	220				typ 800
Anisotropic plastic-bonded Ferroxdure, $BaFe_{12}O_{19}$ Magnets are produced by injection moulding.											
FXD SP130	11	10	240	230	175	167	240				typ 800
Isotropic plastic-bonded Ferroxdure, $BaFe_{12}O_{19}$ Magnets from SP5, SP10 and SP50 are produced by injection moulding, P30 and P40 by extruding, and D55 by pressing and hardening; the suffix "F" denotes flame-retardant material to UL94 V-1.											
FXD SP5F	0,7		65 max	60	50	45	190				typ 800
FXD SP10/SP10F	0,9	0,8	80	75	58	54	190				typ 800
FXD P30	2,8	2,4	125	115	88	84	190				typ 800
FXD P40/P40F	3,6	3,2	145	135	96	88	190				typ 800
FXD SP50	4,4	4	155	150	104	100	190				typ 800
FXD D55	4,8	4,4	170	165	112	104	220				typ 800
Anisotropic metal alloy Ticonal Magnets are cast and may be ground.											
Ticonal 440	35	32,6	1160	1100	55,7	54,1			800	43,8	min 239
Ticonal 500	40,6	37,4	1250	1200	52,5	50,1			1000	40,6	min 239
Ticonal 550	43,8	39,8	900	850	123	115			550	79,6	min 478
Ticonal 570	45,4	42,2	1320	1260	51,7	49,4			1070	42,2	min 239
Ticonal 600	47,8	43,8	1310	1260	54,1	51,7			1090	43,8	min 239

survey of material grades – c.g.s. units

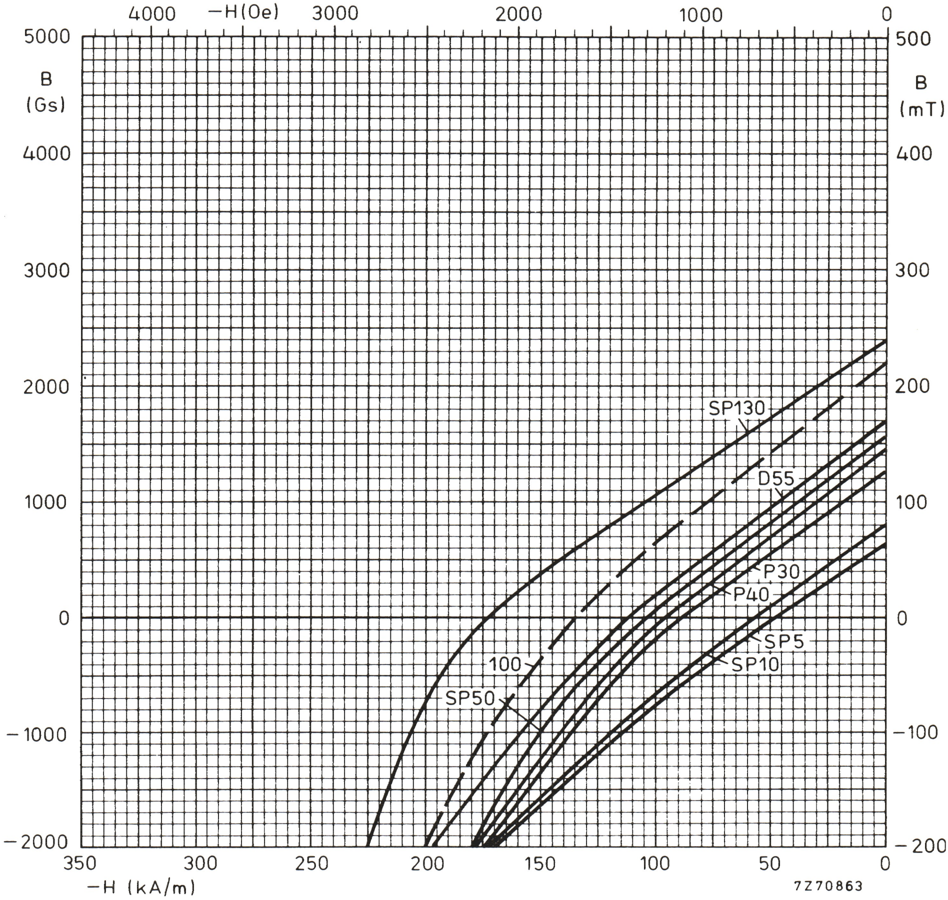
The minimum values ("min") quoted are guaranteed for specified test pieces. Minimum values of B_r and H_{cB} do not occur simultaneously. The minimum value of B_r coincides with an H_{cB} well above the quoted typical value, whereas the minimum value of H_{cB} is coupled with a high value of B_r.

	max BH product		remanence		coercivity		polarization coercivity		B and H at $(BH)_{max}$		saturation field strength
	$(BH)_{max}$ (MGsOe)		B_r (Gs)		H_{cB} (Oe)		H_{cJ} (Oe)		B_d(Gs)	H_d(Oe)	H_{sat} (Oe)
	typ	min	typ	min	typ	min	typ	min	typ	typ	
Anisotropic ceramic Ferroxdure, $SrFe_{12}O_{19}$, (Ferroxdure 300: $BaFe_{12}O_{19}$) Magnets are pressed and sintered and may be ground.											
FXD 270	2,7	2,5	3400	3300	3300	3100	4200	4000	1650	1650	min 14000
FXD 330	3,2	3,0	3700	3600	3000	2800	3100	2900	1800	1800	min 11000
FXD 360	3,6	3,4	3900	3800	2500	2300	2600	2400	2000	1800	min 9000
FXD 380	3,5	3,3	3900	3800	3300	3100	3500	3300	1875	1875	min 12000
FXD 300	3,7	3,5	4000	3900	2000	1800	2050	1850	2400	1550	min 7000
Isotropic ceramic Ferroxdure, $BaFe_{12}O_{19}$ Magnets are pressed or extruded, sintered and may be ground.											
FXD 100	0,95	0,9	2200	2100	1700	1630	2760				typ 10000
Anisotropic plastic-bonded Ferroxdure, $BaFe_{12}O_{19}$ Magnets are produced by injection moulding.											
FXD SP130	1,4	1,3	2400	2300	2200	2100	3020				typ 10000
Isotropic plastic-bonded Ferroxdure, $BaFe_{12}O_{19}$ Magnets from SP5, SP10 and SP50 are produced by injection moulding, P30 and P40 by extruding, and D55 by pressing and hardening; the suffix "F" denotes flame-retardant material to UL94 V-1.											
FXD SP5F	0,088		650 max	600	628	565	2390				typ 10000
FXD SP10/SP10F	0,11	0,1	800	750	729	679	2390				typ 10000
FXD P30	0,35	0,30	1250	1150	1110	1050	2390				typ 10000
FXD P40/P40F	0,45	0,4	1450	1350	1210	1110	2390				typ 10000
FXD SP50	0,55	0,5	1550	1500	1310	1260	2390				typ 10000
FXD D55	0,6	0,55	1700	1650	1410	1310	2760				typ 10000
Anisotropic metal alloy Ticonal Magnets are cast and may be ground.											
Ticonal 440	4,4	4,1	11600	11000	700	680			8000	550	min 3000
Ticonal 500	5,1	4,7	12500	12000	660	630			10000	510	min 3000
Ticonal 550	5,5	5,0	9000	8500	1550	1450			5500	1000	min 6000
Ticonal 570	5,7	5,3	13200	12600	650	620			10700	530	min 3000
Ticonal 600	6,0	5,5	13100	12600	680	650			10900	550	min 3000

Sintered Ferroxdure T = 25 °C

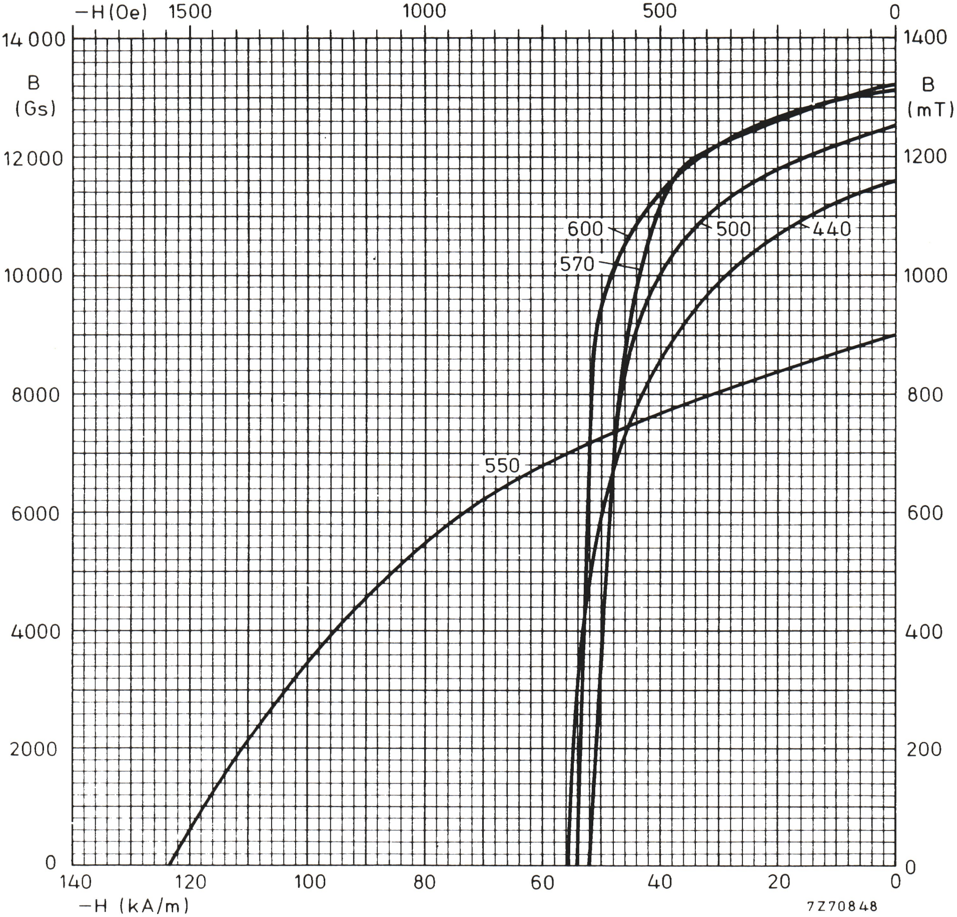


Except for FXD 300 and FXD 360 the curves have a long straight section. Magnets made from these materials can, therefore, be subjected to strong demagnetization, in some cases until B = 0, and yet recoil to nearly their original flux density after the demagnetization influence is removed.



These curves also have a long straight section. Magnets made from these materials can, therefore, be subjected to strong demagnetization, up to B = 0, and yet recoil to nearly their original flux density after the demagnetization influence is removed.
Ferroxdure 100 curve added for comparison.

Ticonal T = 25 °C



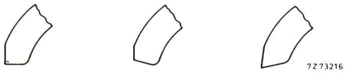
Permanent magnets from Ticonal (and FXD 300) should generally be magnetized only after being built into their magnetic circuit since their demagnetization curves permit little self-demagnetization. Furthermore, magnetization after assembly considerably simplifies handling and the removal of magnetic particles from the magnet.

segment magnets

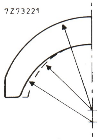
Updated lists of those Ferroxdure segment magnets for which tools exist are available on request. For special applications please let us have details so that our computer can calculate the optimum design.

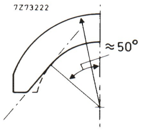
Inside radii with angle up to 170°

Variants on the feet

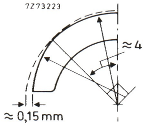


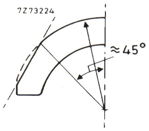
Variants on the inner radii





Variants on the outer radii





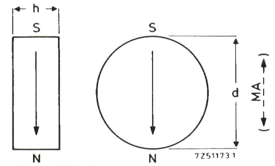
Design advisory service: customers can make use of our experts for assistance in the choice of material, design and magnetization, especially if custom-made products are required.

permanent magnet materials

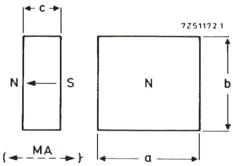
magnetization

Magnetization possibilities and how to specify them. Symbol ← MA → stands for the preferred direction of magnetization in anisotropic material (magnetic axis). Symbol S ——→ N stands for the direction of magnetization in magnetized magnets.

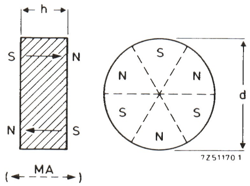
Isotropic and anisotropic magnets


h
S
N
S
N
d
(← MA →)
7Z51173.1

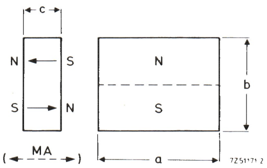
diametrical
(to be used also for rings and cylinders).


c
N
S
N
b
(← MA →)
a
7Z51172.1

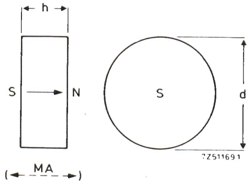
perpendicular to a x b.


h
S
N
N
S
S
N
N
S
N
S
N
S
d
(← MA →)
7Z51170.1

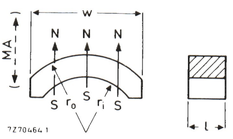
axial, n poles,
neutral zones radial
(in the example n = 6).


c
N
S
S
N
N
S
b
(← MA →)
a
7Z51171.2

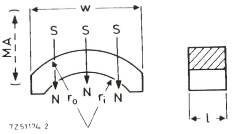
perpendicular to a x b, n poles,
neutral zone parallel to side a
(in the example n = 2).


h
S
N
S
d
(← MA →)
7Z51169.1

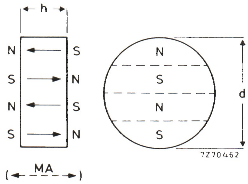
axial


(← MA →)
w
N
N
N
S
r_o
S
r_i
S
l
7Z70464.1

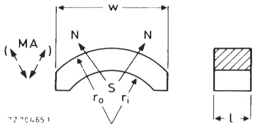
parallel (also called diametrical),
S-pole inside.


(← MA →)
w
S
S
S
N
r_o
N
r_i
N
l
7Z51174.2

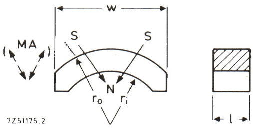
parallel (also called diametrical),
N-pole inside.


h
N
S
S
N
N
S
S
N
N
S
N
S
d
(← MA →)
7Z70462

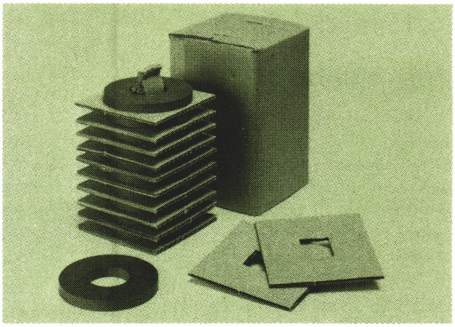
axial, n poles,
neutral zones in parallel
(in the example n = 4).


w
(MA)
N
N
S
r_o
r_i
l
7Z70465.1

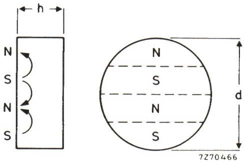
radial, S-pole inside.


w
(MA)
S
S
N
r_o
r_i
l
7Z51175.2

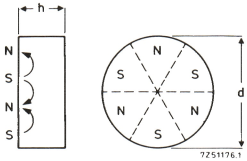
radial, N-pole inside.



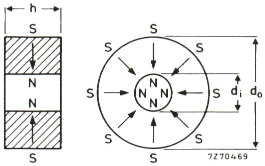
Isotropic magnets only


h
N
S
N
S
N
S
N
S
d
7Z70466

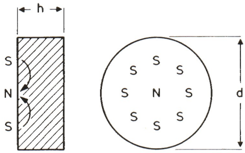
lateral, n parallel poles on one face only, (in the example n = 4).


h
N
S
N
S
N
S
S
N
N
S
d
7Z51176.1

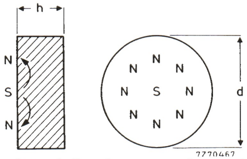
lateral, n pole sectors on one face only, (in the example n = 6).


h
S
N
N
S
S
N
S
d_i
d_o
7Z70469

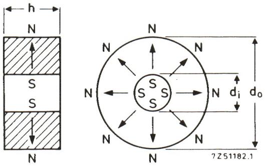
radial, N-pole inside.


h
S
N
S
S
N
S
d
7Z51177.1

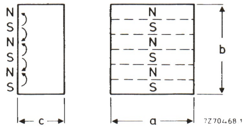
lateral, 2 poles on one face only, centred N-pole with concentric S-pole.


h
N
S
N
N
S
N
d
7Z70467

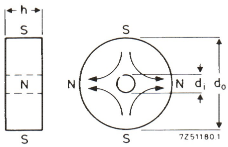
lateral, 2 poles on one face only, centred S-pole with concentric N-pole.


h
N
S
S
N
N
S
N
d_i
d_o
7Z51182.1

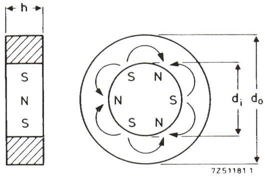
radial, S-pole inside.


N
S
N
S
N
S
c
a
b
7Z70468.1

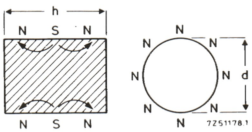
lateral, n poles on one a x b face, poles parallel to side a (in the example n = 6).


h
S
N
S
N
d_i
d_o
7Z51180.1

lateral, n poles on outer circumference, neutral zones axial (in the example n = 4).


h
S
N
S
N
S
d_i
d_o
7Z51181.1

lateral, n poles on inner circumference, neutral zones axial (in the example n = 6).


h
N S N
N S N
N
N
N
N
d
7Z51178.1

lateral, n annular poles (in the example n = 3).

soft ferrites

Ferroxcube

Ferroxcube MnZn and NiZn ferrites are intended for use as core material in coils and transformers operating over a wide range of frequencies. The finished cores, having a stable structure and low losses are made in various grades featuring optimum performance for the relevant application. They are available in a number of standard shapes but can also be ordered to suit a special job.

For detailed information
Handbook CM4a

Ferroxcube cores for professional applications

- potcores acc. to IEC — for stable low-loss filters, coils and transformers; types: P9/5, P11/7, P14/8, P18/11, P22/13, P26/16, P30/19, P36/22, P42/29, P66/56
- square cores acc. to IEC — same applications; types: RM4, RM5, RM6-R, RM6-S, RM8, RM10, RM14
- cross cores acc. to IEC — same applications; types: X22, X30, X35
- E-I cores acc. to DIN — for transformers up to 2 or 3 MHz; types: E13/7/3, E20/10/5, E30/15/7, E42/21/15, E42/21/20, E42/33/20, E55/28/21, E65/32/13, E65/33/27
- EC and E cores acc. to IEC — for power applications; types: EC35/17/10, EC41/19/12, EC52/24/14, EC70/34/17
- toroids — for broadband and pulse transformers

Ferroxcube cores for audio and video

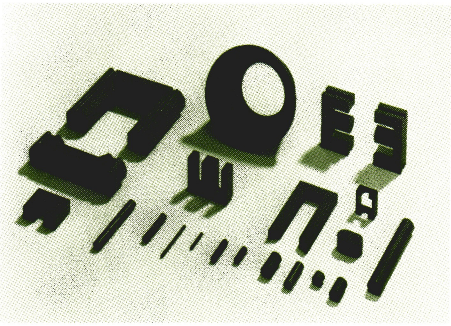
- antenna rods — for a.m. receivers
- rods
- tubes
- screw cores
- frame cores
  — for fixed inductances, e.g. small coils, i.f. transformers, etc. and for adjustable inductances, e.g. crossover filters
- beads — for screening, damping and wide-band h.f. chokes, interference suppression
- twin beads — for coupling transformers
- yoke rings — for deflection coils for picture tubes
- U-I cores — for chokes, coils, line-output transformers
- E cores — for driver and power transformers, and transductors
- L cores — for convergence units
- rod cores — for linearity controls, and blue lateral units
- tooth cores — for erasing heads

Mounting parts

A variety of coil formers and mounting parts for most of the core types are available.

Inductance adjusters

Adjusters are available for application in pre-adjusted potcores, square cores and cross cores if very accurate inductance tolerances are required.



Ferroxcube grades	initial permeability (μ_i) at B ≤ 0,1 mT 4 kHz, 25 °C tolerance ± 20/25%	available core shapes														
		rod	tube	bead	frame	screw	tooth	antenna	yoke rings	L	E-I, EC	U-I	pot	square	cross	toroid
MnZn (Ferroxcube 3)																
3B	900	●	●	●	●	●										
3B3	900					●										
3B5	400	●	●													
3B8	2000												●	●	●	
3B7	2300												●	●	●	●
3C2	900	●	●						●	●		●				
3C6	1700	●	●								●	●				
3C8	2000	●									●	●				
3D3	750	●	●		●	●							●	●	●	
3E1	3800										●		●	●	●	●
3E2	≥ 5000															●
3E3	≥ 10000															●
3E4	4700												●	●		
3H1	2300												●	●	●	
3H2	2300		●				●									●
3H3	2200												●	●		
NiZn (Ferroxcube 4)																
4A1	600	●	●	●												
4A4	500				●											
4A10	350							●								
4B1	250	●	●	●	●											
4C1	125		●													
4C5	100	●														
4C6	120												●	●	●	●
4D1	50	●	●	●	●	●										
4D2	60		●			●										
4E1	15	●	●													
special grades																
8C1	1500						●									
8H1	3000						●									
4H1	250															
4L1	200															
4L2	220															
4MX	150															
8C11	1200															
8C12	1000															
8C13	600															

piezoelectric ceramics

principal properties

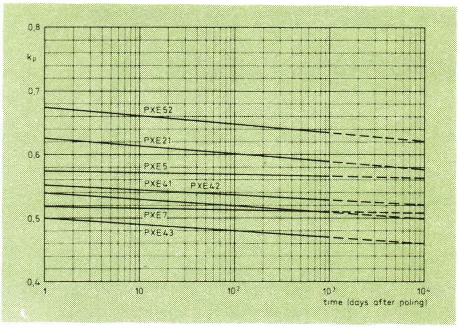
The following grades, consisting of modified lead zirconate titanates are distinguished according to their electrical and mechanical properties and field of application.

As we are optimizing the specific properties continuously, new grades may well be added to our existing range at any time.

We recommend that designers keep themselves informed of our latest technological developments.

property and symbol		unit	PXE5
thermal data			
Curie temperature		°C	285
specific heat		J/kg °C	420
thermal conductivity		W/m °C	1,2
mechanical data			
density ρ_m		10^3 kg/m^3	7,65
compliance	s_{33}^E	10^{-12} /Pa	17,2
	s_{11}^E		15,3
	s_{55}^E		38,5
Poisson's ratio σ			≈ 0,3
mechanical quality factor for radial mode Q_m^E			≈ 80
frequency constants	N_p^E	Hz m or m/s	2000
	$N_3^D = \frac{1}{2} v_3^D$		1900
	$N_1^E = \frac{1}{2} v_1^E$		1460
	$N_5^E = \frac{1}{2} v_5^E$		930
compressive strength		10^6 Pa	> 600
tensile strength			≈ 80
electrical data			
relative permittivity	$\epsilon_{33}^T/\epsilon_0$		1800
($\epsilon_0 = 8{,}85.10^{-12}$ F/m)	$\epsilon_{11}^T/\epsilon_0$		1800
resistivity ρ_{el} (25 °C)		10^{12} Ωm	1
time constant $\rho_{el}\,\epsilon_{33}^T$ (25 °C)		min	> 250
dielectric loss factor tan δ		10^{-3}	20
electro-mechanical data			
coupling factor	k_p		0,60
	k_{33}		0,69
	k_{31}		0,35
	k_{15}		0,66
piezoelectric charge constants	d_{33}	10^{-12} C/N or m/V	362
	d_{31}		− 175
	d_{15}		515
piezoelectric voltage constants	g_{33}	10^{-3} Vm/N or m^2/C	22,7
	g_{31}		− 11,0
	g_{15}		32,5
time stability			
coupling factor k_p		relative change per time decade (%)	− 0,5
permittivity ϵ_{33}^T			− 1
frequency constant N_p^E			0,5
quality factor Q_m^E			
dielectric loss factor tan δ			

The properties of components manufactured from PXE are dependent on the dimensions of the product and method of manufacture, and also on the measuring level. Therefore a meaningful interpretation of the properties of the material is best done in consultation with the supplier.



Stability as a function of time.

PXE52*	PXE7	PXE21	PXE41	PXE42	PXE43
170	320	270	315	325	300
420	420	420	420	420	420
1,2	1,2	1,2	1,2	1,2	1,2
7,90	7,75	7,75	7,90	7,70	7,70
18,4	15,8	18,6	14,6	15,3	12,6
14,7	12,5	15,1	12,2	12,7	11,3
	33,2		37,0		
0,3	≈ 0,3	≈ 0,3	≈ 0,3	≈ 0,3	0,3
≈ 50	≈ 80	≈ 80	≈ 1000	≈ 750	1000
2000	2200	2000	2200	2200	2350
1920	2000	1900	2000	2015	2050
	1640		1620		
	1025		950		
> 600	> 600	> 600	> 600	> 600	> 600
≈ 80	≈ 80	≈ 80	≈ 80	≈ 80	≈ 80
3500	820	1750	1200	1300	1000
	1200		1400		
	1	0,1	0,05		
	> 100	> 25	> 7		
22	20	18	2,5	2,5	2
0,63	0,56	0,62	0,58	0,58	0,50
0,73	0,70	0,72	0,68	0,68	0,63
0,37	0,32	0,37	0,34	0,34	0,30
	0,64		0,70		
550	220	385	268	285	210
− 250	− 99	− 180	− 119	− 130	−95
	405		480		
17,8	35,7	25,0	25,2	25,0	25,0
− 8,1	− 13,5	− 11,6	− 11,6	− 11,0	−10,7
	38		38,5		
	− 0,5	− 1,5	− 1,5	− 2,5	− 2
	− 0,5	− 2	1	− 6,0	− 4,5
	1,0	0,5	0,5	1,5	1
			10		
			− 10		

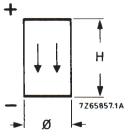
Unless otherwise specified the values given are nominal ones measured at 20 ± 5 °C.

* Preliminary data.

piezoelectric ceramics

cylinders for gas ignition

PXE cylinders are capable of generating voltages high enough to produce a spark that will ignite combustible gases.



The end faces of the cylinders are silver-plated. The direction of polarization is axial. The electrode which has been connected to the positive terminal of the polarization apparatus, is identified.

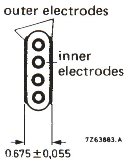
	dimensions ϕ x H (mm)	material grade	catalogue number
Cylinders for impact mechanisms in domestic and industrial appliances	6,35 x 16	**PXE21**	4322 020 05070
Cylinders for squeezing mechanisms in domestic appliances	6,35 x 15	**PXE41**	05630
	6,35 x 16	**PXE41**	05640

Piezoelectric household gas lighter.

multimorph and bimorph flexure elements

Multimorph strips can be used for both mono and stereo high-output pick-up heads as well as for fine movement control and detection systems in industrial applications.
Bimorph plates are used to transmit and receive ultrasound in air, movement detection, etc.

Multimorph elements


outer electrodes
inner electrodes
7Z63883.A
0.675 ±0,055

Maximum capacitance (pF):
52 x length in mm

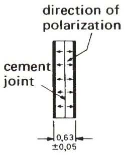
Maximum bending moment:
1,6 x 10^{-3} Nm

Minimum bending moment to fracture: 7,5 x 10^{-3} Nm

These **PXE5** elements are available in various lengths.

length (mm)	catalogue number outer electrode negative	positive
9,6	4322 020 04760	4322 020 04750
12,7	02480	02460
15,5	02490	02470
70	04830	—

Bimorph plates


direction of polarization
cement joint
0,63 ±0,05

Resonance frequency:
34,5 ±3,0 kHz

Capacitance at 1 kHz:
1450 ± 290 pF

Dimensions: 8 x 8 x 0,63 mm
Material grade: **PXE5**
Catalogue number: 4322 020 08120

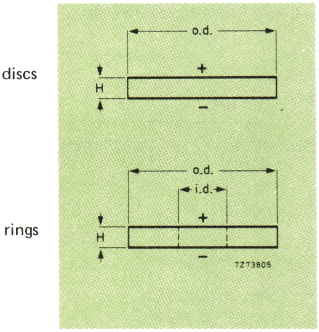
Bimorph plates with other dimensions are available on request.

PHILIPS
PHILIPS

Stereo pick-up head with PXE multimorph elements.

piezoelectric ceramics

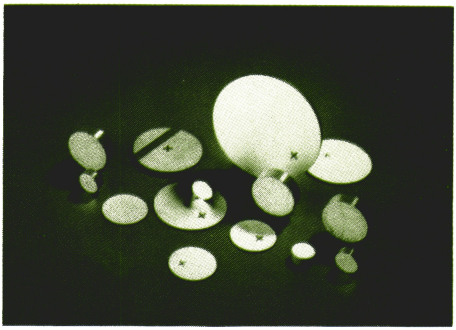
high-intensity transducers



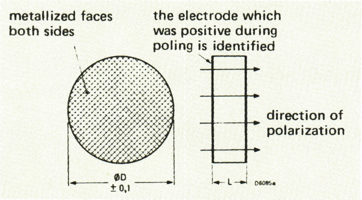
The electrodes of the discs and rings are silver-plated. The direction of polarization is axial. The electrode which has been connected to the positive terminal of the polarization apparatus, is identified.

PXE41	**PXE42**	**PXE43**	
underwater acoustics	ultrasonic cleaning	ultrasonic welding drilling machining	catalogue numer
ϕ 20 x ϕ 6 x 5			8222 293 23470
ϕ 25 x ϕ 8 x 5			8222 293 22081
ϕ 25,4 x ≈ 10,2 (200 kHz)			4322 020 05750
ϕ 31,75 x ≈ 14,3 (151 kHz)			4322 020 05240
	ϕ 38 x 6,35		4322 020 05660
	ϕ 38,1 x ϕ 12,7 x 4		4322 020 06090
	ϕ 38,1 x ϕ 12,7 x 6,35		4322 020 06040
		ϕ 38,1 x ϕ 19,1 x 5	8222 293 23070
	ϕ 38,1 x ϕ 19,1 x 6,35		4322 020 06070
ϕ 50 x 3			4322 020 05590
		ϕ 50 x ϕ 20 x 5	8222 293 22480
	ϕ 50 x ϕ 20 x 6		4322 020 06050
		ϕ 50 x ϕ 20 x 6	8222 293 21150
	ϕ 50,5 x ϕ 17 x 6,35		8222 293 22770

discs and plates



Discs

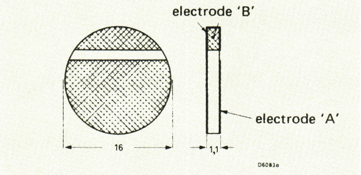

metallized faces both sides
the electrode which was positive during poling is identified
direction of polarization
ØD ± 0,1
L
D6085a

dimensions D X L (mm)	catalogue number
3 x 0,5	4322 020 05250
5 x 0,2	05260
0,3	05270
0,5	05280
1	05300
2	05310
10 x 0,2	05320
0,3	05330
0,5	05340
1	02330
2	05350
3	05360
5	05370

dimensions D x L (mm)	catalogue number
16 x 0,2	4322 020 05390
0,3	05400
0,5	05410
1,1	02250
2	05420
3	02300
25,4 x 0,5	05430
1	05440
2	05450

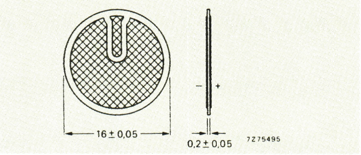
material grade: **PXE5**

Feedback discs


electrode 'B'
electrode 'A'
16
1,1
D6083a

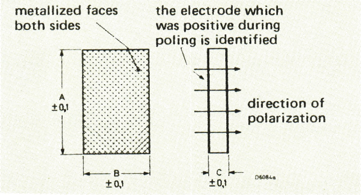
Polarity of electrode 'A' during poling:

negative, catalogue number 4322 020 02260
positive, catalogue number 4322 020 02270
Material grade: **PXE5**
Electrode 'B' is a wrap-around electrode.


−
+
16 ± 0,05
0,2 ± 0,05
7Z75495

Three-electrode disc for tone generation
catalogue number 8222 293 22582
Material grade: **PXE5**

Plates


metallized faces both sides
the electrode which was positive during poling is identified
direction of polarization
A ±0,1
B ±0,1
C ±0,1
D6084a

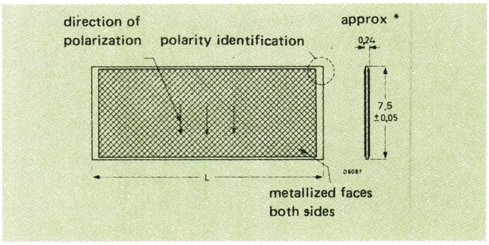
dimensions A x B x C (mm)	material grade	catalogue number
2,54 x 2,54 x 2,56	PXE21	4322 020 07310
6 x 4 x 0,5	PXE5	07150
12 x 6 x 0,5	PXE5	07050
12 x 6 x 1	PXE5	07060
16 x 12 x 1	PXE5	02310

piezoelectric ceramics

delay line transducers and material

Electro-mechanical transducers for converting electric signals to acoustic signals and vice versa after the signals have travelled through an acoustic delay medium.
Example: chrominance delay lines in colour tv.

Transducers

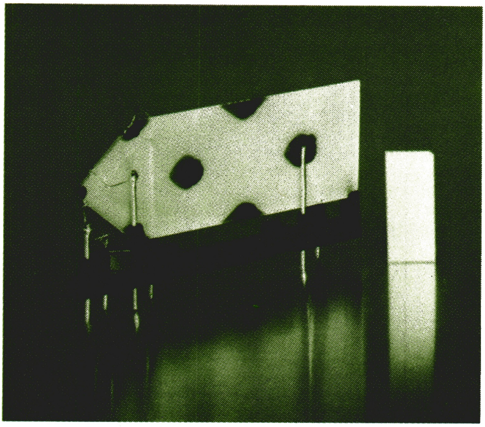

direction of polarization
polarity identification
approx *
0,24
7,5
±0,05
L
D6087
metallized faces both sides

* Frequency of shear vibration:
4,1 MHz ± 0,1 MHz

dimension L (mm)	catalogue number
29 ± 0,05	4322 040 02910

Material grade: **PXE7**

Typical delay line with plastic housing removed.



CONTENTS ELECTRON TUBES

For detailed information
Handbooks ET1a/b, 2a/b, 3, 4, 5a/b, 6, 7a/b, 8, 9

			page
CONSUMER	receiving tubes		C212 – C219
	picture tubes	black and white tv	C152 – C154
		colour tv	C158 – C159
PROFESSIONAL	special quality tubes		C220 – C224
	tubes for r.f. heating		C226 – C227
	transmitting tubes		C228 – C241
	amplifier circuit assemblies		C242
	camera tubes		C244 – C248
	image intensifier tubes		C249
	cathode-ray tubes		C250 – C253
	microwave products		C254 – C259
	gas-filled tubes		C260 – C261
	products for nuclear technology		C262 – C263
	photomultipliers		C264 – C273
	phototubes		C274
REPLACEMENTS	replacement guide for electron tubes		C275 – C288
		receiving tubes	C275
		professional tubes	C276 – C288

receiving tubes

survey

* Types described in this section

*DY802
EC86
EC88
*EC900
ECC81

*ECC82
*ECC83
ECC85
ECC88
ECC89

ECC189
*ECF80
ECF86
ECF200
ECF201

*ECF801
*ECF802
ECH81
ECH83
ECH84

ECH200
*ECL82
ECL84
*ECL86
*ECL805

*ED500
EF80
EF85
EF86
*EF183

*EF184
*EFL200
EL34
EL36
EL84

EL86
*EL95
EL503
*EL504
*EL508

*EL509
*EL519
EL802
*EY81
*EY88

*EY500A
*EY802
*GY501
GZ34
PABC80

PC86
PC88
PC97
*PC900
PCC85

PCC88
PCC189
*PCF80
PCF86
*PCF200

*PCF201
*PCF801
*PCF802
PCH200
*PCL82

PCL84
*PCL86
*PCL805
*PD500
*PD510

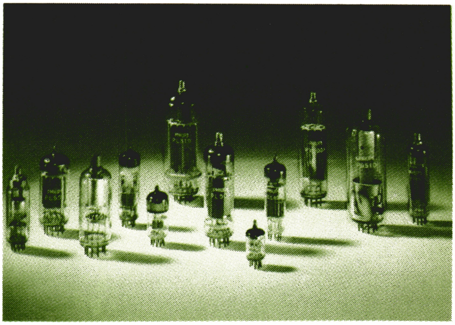
PF86
*PFL200
PL36
PL81
PL82

PL83
PL84
*PL95
*PL504
*PL508

*PL509
*PL519
*PL802
*PY81
PY82

*PY88
*PY500A
UABC80
UAF42
UBF89

UCC85
UCL82
UF41
UL84

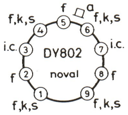


DY802
e.h.t.
single-anode
rectifier

V_f = 1,4 V
I_f = 0,6 A

V_o = 20 kV
I_o = 0,2 mA

$-V_{ap}$ = max. 25 kV
I_o = max. 0,5 mA
I_{op} = max. 50 mA
C_{filt} = max. 3 nF


f
a
f,k,s
f,k,s
i.c.
i.c.
DY802
noval
f
f
f,k,s
f,k,s
1
2
3
4
5
6
7
8
9

EC900

V_f = 6,3 V
I_f = 0,18 A

For further data see PC900

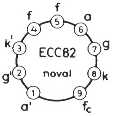
ECC82
a.f.
double triode

V_f = 6,3 V
I_f = 0,3 A
or
V_f = 12,6 V
I_f = 0,15 A

V_a = 250 V
V_g = −8,5 V

I_a = 10,5 mA
S = 2,2 mA/V
μ = 17

Operating as a.f. amplifier
V_b = 250 V, R_a = 0,1 MΩ, R_k = 2,2 kΩ, V_o/V_i = 14, d = 5,9%


f
f
a
k'
g
ECC82
noval
g'
k
a'
f_c
1
2
3
4
5
6
7
8
9

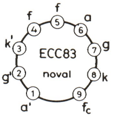
ECC83
a.f.
double triode

V_f = 6,3 V
I_f = 0,3 A
or
V_f = 12,6 V
I_f = 0,15 A

V_a = 250 V
V_g = −2 V

I_a = 1,2 mA
S = 1,6 mA/V
μ = 100

Operating as a.f. amplifier
V_b = 250 V, R_a = 0,1 MΩ, R_k = 1,5 kΩ, V_o/V_i = 54,5, d = 3,9%


f
f
a
k'
g
ECC83
noval
g'
k
a'
f_c
1
2
3
4
5
6
7
8
9

ECF80

V_f = 6,3 V
I_f = 0,43 A

For further data see PCF80

ECF801

V_f = 6,3 V
I_f = 0,41 A

For further data see PCF801

ECF802

V_f = 6,3 V
I_f = 0,43 A

For further data see PCF802

ECL82

V_f = 6,3 V
I_f = 0,78

For further data see PCL82

ECL86

V_f = 6,3 V
I_f = 0,66 A

For further data see PCL86

ECL805

V_f = 6,3 V
I_f = 0,875 A

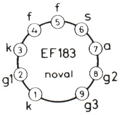
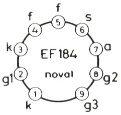
For further data see PCL805

ED500

V_f = 6,3 V
I_f = 0,35 A

For further data see PD500

receiving tubes

EF183 remote cut-off pentode	V_f = 6,3 V I_f = 0,3 A	V_a = 200 V V_{g2} = 90 V V_{g3} = 0 V	V_{g1} = −2 V I_a = 12 mA I_{g2} = 4,5 mA	S = 12,5 mA/V R_i = 0,5 MΩ	 f f s k a EF183 noval g1 g2 k g3 1 2 3 4 5 6 7 8 9
EF184 sharp cut-off pentode	V_f = 6,3 V I_f = 0,3 A	V_a = 200 V V_{g2} = 200 V V_{g3} = 0 V V_{g1} = −2,5 V	I_a = 10 mA I_{g2} = 4,1 mA S = 15 mA/V	R_i = 380 kΩ μ_{g2g1} = 60	 f f s k a EF184 noval g1 g2 k g3 1 2 3 4 5 6 7 8 9
EFL200	V_f = 6,3 V I_f = 0,81 A	For further data see PFL200			
EL95	V_f = 6,3 V I_f = 0,2 A	For further data see PL95			
EL504	V_f = 6,3 V I_f = 1,38 A	For further data see PL504			
EL508	V_f = 6,3 V I_f = 0,84 A	For further data see PL508			
EL509	V_f = 6,3 V I_f = 2 A	For further data see PL509			
EL519	V_f = 6,3 V I_f = 2 A	For further data see PL519			
EY81	V_f = 6,3 V I_f = 0,81 A	For further data see PY81			
EY88	V_f = 6,3 V I_f = 1,55 A	For further data see PY88			
EY500A	V_f = 6,3 V I_f = 2,1 A	For further data see PY500A			
EY802	V_f = 6,3 V I_f = 0,12 A	For further data see DY802			

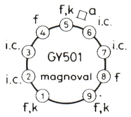
GY501
single-anode
e.h.t. rectifier

V_f = 3,15 V
I_f = 0,4 A

Operating as rectifier
V_o = 25 kV
I_a = 1,5 mA

$-V_{ap}$ = max. 35 kV
V_o = max. 27,5 kV

I_a = max. 1,7 mA
I_{ap} = max. 100 mA


f,k
a
f
i.c.
i.c.
i.c.
GY501
magnoval
i.c.
f
f,k
f,k
1
2
3
4
5
6
7
8
9

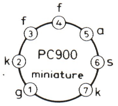
PC900
v.h.f. triode

V_f = 3,9 V
I_f = 0,3 A

V_a = 135 V
V_s = 0 V

V_g = −1V
I_a = 11,5 mA

S = 14,5 mA/V
μ = 76


f
f
a
k
PC900
miniature
s
g
k
1
2
3
4
5
6
7

PCF80
triode-
pentode

V_f = 9,0 V
I_f = 0,3 A

Pentode

V_a = 170 V
V_{g2} = 170 V
V_{g1} = −2 V

I_a = 10 mA
I_{g2} = 2,8 mA
S = 6,2 mA/V

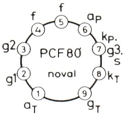
R_i = 0,4 MΩ
μ_{g2g1} = 47

Triode

V_a = 100 V
V_g = −2 V

I_a = 14 mA
S = 5 mA/V

μ = 20


f
f
ap
kp.
g2
PCF80
g3.
s
g1
noval
kT
aT
gT
1
2
3
4
5
6
7
8
9

PCF200
triode-
pentode

V_f = 8,5 V
I_f = 0,3 A

Pentode-typical

V_a = 160 V
V_{g2} = 135 V
V_{g3} = 0 V

V_{g1} = −1,7 V
I_a = 13 mA
I_{g2} = 5,3 mA

S = 14 mA/V
μ_{g2g1} = 53

Pentode-operating as sound or video i.f. amplifier

V_b = 230 V
R_a = 5,6 kΩ
R_{g2} = 22 kΩ

R_k = 83 Ω
I_a = 12,5 mA
I_{g2} = 5,1 mA

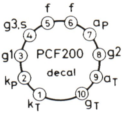
S = 14 mA/V

Triode-typical

V_a = 170 V
V_g = −1V

I_a = 8,5 mA
S = 5,2 mA/V

μ = 57


f
f
g3,s
ap
g1
PCF200
decal
g2
kp
aT
kT
gT
1
2
3
4
5
6
7
8
9
10

PCF201
triode-
pentode

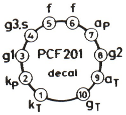
V_f = 8,0 V
I_f = 0,3 A

Pentode-typical

V_a = 160 V
V_{g2} = 110 V
V_{g3} = 0 V

V_{g1} = −1,4 V
I_a = 13 mA
I_{g2} = 5,3 mA

S = 12,6 mA/V
μ_{g2g1} = 45


f
f
g3,s
a_P
g1
PCF201
g2
decal
k_P
a_T
k_T
g_T
1
2
3
4
5
6
7
8
9
10

Pentode-operating as video i.f. amplifier

V_b = 250 V
R_a = 6,8 kΩ
R_{g2} = 27 kΩ
V_{g3} = 0 V

R_k = 76 Ω
I_a = 12,8 mA
I_{g2} = 5,2 mA

S = 12,6 mA/V

Triode-typical

V_a = 100 V
V_g = −2 V

I_a = 14 mA
S = 4,8 mA/V

μ = 17,5

PCF801
triode-
pentode

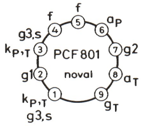
V_f = 8,5 V
I_f = 0,3 A

Pentode-typical

V_a = 170 V
V_{g2} = 120 V
V_{g1} = − 1,4 V

I_a = 10 mA
I_{g2} = 3 mA
S = 11 mA/V

R_i = > 350 kΩ
μ_{g2g1} = 55
R_{eq} = 1,5 kΩ


f
f
a_P
g3,s
$k_{P,T}$
PCF801
g2
g1
noval
a_T
$k_{P,T}$
g3,s
g_T
1
2
3
4
5
6
7
8
9

Pentode-operating as mixer

V_{ba} = 200 V
V_{bg2} = 200 V
V_{osc} = 1,6 V(r.m.s.)

R_a = 2,7 kΩ
R_{g2} = 27 kΩ
R_{g1} = 0,1 MΩ

I_{g2} = 3 mA
I_{g1} = 8 μA
S_c = 5 mA/V

Triode-typical

V_a = 100 V
V_g = −3 V

I_a = 15 mA
S = 9 mA/V

μ = 20

PCF802
triode-
pentode

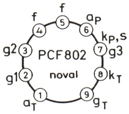
V_f = 9,0 V
I_f = 0,3 A

Pentode

V_a = 100 V
V_{g2} = 100 V
V_{g1} = −1 V

I_a = 6 mA
I_{g2} = 1,7 mA
S = 5,5 mA/V

R_i = 0,4 MΩ
μ_{g2g1} = 47


f
f
a_P
k_P,s
g2
PCF802
g3
g1
noval
k_T
a_T
g_T
1
2
3
4
5
6
7
8
9

Triode

V_a = 200 V
V_g = −2V

I_a = 3,5 mA
S = 3,5 mA/V

μ = 70

PCL82
triode-
output pentode

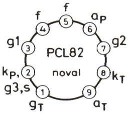
V_f = 16 V
I_f = 0,3 A

Pentode- operating as class-A power amplifier

V_{ba} = V_{bg2} = 230 V
R_{g2} = 1,2 kΩ
R_k = 490 Ω
$R_{a\sim}$ = 6 kΩ

I_a = 30 mA
I_{g2} = 6,6 mA
at V_i = 0 V

I_a = 31 mA
I_{g2} = 11 mA
at V_i = 7,8 V(r.m.s.)
W_o = 3,25 W
d_{tot} = 10%
W_a = max. 7 W


f
f
a_P
g1
PCL82
g2
k_P,
noval
k_T
g3,s
g_T
a_T
1
2
3
4
5
6
7
8
9

Triode- operating as a.f. amplifier

V_b = 200 V
R_a = 220 kΩ
R_k = 2,2 kΩ

R_g = 3 MΩ
R_g' = 0,68 MΩ
I_a = 0,52 mA

V_o/V_i = 52
V_o = < 26 V(r.m.s.)
d_{tot} = 1,6%

Typical characteristics unless otherwise specified.

PCL86
triode-output pentode

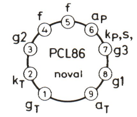
V_f = 13,3 V
I_f = 0,3 A

Pentode- operating as class-A power amplifier

V_a = 230 V
V_{g2} = 230 V
R_k = 125 Ω
$R_{a\sim}$ = 5,1 kΩ

I_a = 39 mA
I_{g2} = 6,5 mA
at V_i = 0 V

I_a = 40,7 mA
I_{g2} = 10,5 mA
at V_i = 3,6 V(r.m.s.)
W_o = 4,1 W
d_{tot} = 10%
W_a = max. 9 W


f
f
a_P
g2
k_P,s,
g3
PCL86
noval
k_T
g1
g_T
a_T
1
2
3
4
5
6
7
8
9

Triode- operating as a.f. amplifier

V_b = 200 V
R_a = 220 kΩ
R_k = 2,6 kΩ

R_g = 680 kΩ
I_a = 0,42 mA
V_o = 3,2 V(r.m.s.)

V_o/V_i = 66
d_{tot} = 0,6%

PCL805
triode-frame output pentode

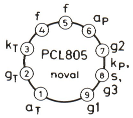
V_f = 17,5 V
I_f = 0,3 A

Pentode- operating as frame output tube

V_a = 50 V
V_{g2} = 170 V

V_{g1} = –1 V
I_{ap} = 200 mA

I_{g2p} = 35 mA
W_a = max. 8 W


f
f
a_P
k_T
g2
PCL805
k_P,
s,
noval
g_T
g3
a_T
g1
1
2
3
4
5
6
7
8
9

Triode-typical

V_a = 100 V
V_g = 0 V

I_a = 10,5 mA
S = 7 mA/V

R_i = 9 kΩ
μ = 63

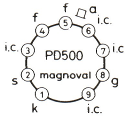
PD500
shunt stabilizer triode

V_f = 7,3 V
I_f = 0,3 A

V_a = 25 kV
V_s = 0 V

$-V_g$(at I_a = 1,5 mA)
= 7 – 30 V

$-V_g$(at I_a = 0,1 mA)
= **< 40 V**
W_a = max. 30 W


f
f
a
i.c.
i.c.
i.c.
PD500
magnoval
s
g
k
i.c.
1
2
3
4
5
6
7
8
9

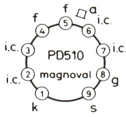
PD510
shunt stabilizer triode

V_f = 7,3 V
I_f = 0,3 A

V_a = 25 kV
V_s = 0 V

$-V_g$(at I_a = 1,5 mA)
= 9 – 28 V

$-V_g$(at I_a = 0,1 mA)
= < 38 V
W_a = max. 30 W


f
f
a
i.c.
i.c.
i.c.
PD510
magnoval
i.c.
g
k
s
1
2
3
4
5
6
7
8
9

PFL200
double
pentode

$V_f = 17$ V
$I_f = 0,3$ A

L section

$V_a = 170$ V
$V_{g2} = 170$ V
$V_{g1} = -2,7$ V

$I_a = 30$ mA
$I_{g2} = 7$ mA
$S = 22$ mA/V

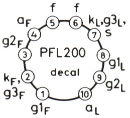
$R_i = 33$ kΩ
$\mu_{g2g1} = 38$
$W_a =$ max. 5,1 W

F section

$V_a = 150$ V
$V_{g2} = 150$ V
$V_{g1} = -2,1$ V

$I_a = 10$ mA
$I_{g2} = 3$ mA
$S = 8,5$ mA/V

$R_i = 150$ kΩ
$\mu_{g2g1} = 38$



f
f
a_F
$k_L, g3_L$,
s
$g2_F$
PFL200
decal
$g1_L$
k_F,
$g3_F$
$g2_L$
$g1_F$
a_L

PL95

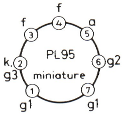
$V_f = 4,5$ V
$I_f = 0,3$ A

Operating as class-A power amplifier

$V_a = 250$ V
$V_{g2} = 250$ V
$R_k = 320$ Ω

$I_a = 24$ mA
$I_{g2} = 4,5$ mA
$R_{a\sim} = 10$ kΩ

$V_i = 5$ V(r.m.s.)
$W_o = 3$ W
$d_{tot} = 10\%$
$W_a =$ max. 6 W



f
f
a
k,
g3
PL95
miniature
g2
g1
g1

PL504
line
output pentode

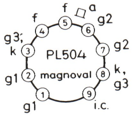
$V_f = 27$ V
$I_f = 0,3$ A

Operating as line output tube

$V_a = 50$ V
$V_{g2} = 200$ V

$V_{g1} = -10$ V
$I_a = 420$ mA
$I_{g2} = 37$ mA

$W_a =$ max. 16 W
$I_k =$ max. 250 mA
$V_{ap} =$ max. 7 kV



f
a
f
g2
g3;
k
PL504
g2
g1
magnoval
k,
g3
g1
i.c.

PL508
frame
output pentode

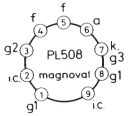
$V_f = 17$ V
$I_f = 0,3$ A

Operating as frame output tube

$V_a = 50$ V
$V_{g2} = 190$ V
$V_{g1} = -1$V

$I_{ap} = 320$ mA
$I_{g2} = 60$ mA

$W_a =$ max. 12 W



f
f
a
g2
PL508
k,
g3
i.c.
magnoval
g1
g1
i.c.

PL509
line
output pentode

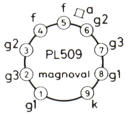
$V_f = 40$ V
$I_f = 0,3$ A

Operating as line output tube

$V_a = 50$ V
$V_{g3} = 0$ V
$V_{g2} = 175$ V
$V_{g1} = -10$ V

$I_{ap} = 800$ mA
$I_{g2} = 70$ mA

$W_a =$ max. 30 W
$I_k =$ max. 500 mA
$V_{ap} =$ max. 7 kV



f
a
f
g2
g2
PL509
g3
g3
magnoval
g1
g1
k

PL519
line
output pentode

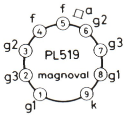
$V_f = 40$ V
$I_f = 0,3$ A

Operating as line output tube

$V_a = 70$ V
$V_{g3} = 0$ V
$V_{g2} = 205$ V
$V_{g1} = -11$ V

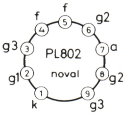
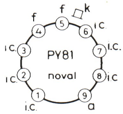
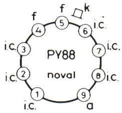
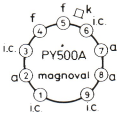
$I_{ap} = 1,1$ A
$I_{g2} = 85$ mA

$W_a =$ max. 35 W
$I_k =$ max. 500 mA
$V_{ap} =$ max. 7 kV



f
a
f
g2
g2
PL519
g3
g3
magnoval
g1
g1
k

Typical characteristics unless otherwise specified.

PL802 video output pentode	V_f = 16 V I_f = 0,3 A	V_a = 170 V V_{g2} = 170 V V_{g1} = V_{g3} = 0 V	R_k = 36 Ω I_a = 30 mA I_{g2} = 6,5 mA	W_a = max. 6 W	 f f g2 g3 a PL802 noval g1 g2 k g3 1 2 3 4 5 6 7 8 9
PY81 booster diode	V_f = 17 V I_f = 0,3 A	Limiting W_a = max. 3,5 W I_a = max. 150 mA I_{ap} = max. 450 mA	$-V_{ap}$ = max. 5 kV V_{kfp} = max. 5 kV		 f f k i.c. i.c. i.c. PY81 noval i.c. i.c. i.c. a 1 2 3 4 5 6 7 8 9
PY88 booster diode	V_f = 30 V I_f = 0,3 A	Limiting W_a = max. 5 W I_a = max. 220 mA I_{ap} = max. 550 mA	$-V_{ap}$ = max. 6 kV V_{kfp} = max. 6,6 kV		 f f k i.c. i.c. i.c. PY88 noval i.c. i.c. i.c. a 1 2 3 4 5 6 7 8 9
PY500A booster diode	V_f = 42 V I_f = 0,3 A	Limiting W_a = max. 11 W I_a = max. 440 mA I_{ap} = max. 1000 mA	$-V_{ap}$ = max. 5,6 kV V_{kfp} = max. 6,3 kV		 f f k i.c. i.c. a PY500A magnoval a a i.c. i.c. 1 2 3 4 5 6 7 8 9

special quality tubes

Pentodes, triodes and double triodes offer
a choice from one or more special features:

- long life
- shock and vibration resistant
- high reliability

For detailed information
Handbook ET3

Pentodes

A wide range of pentodes for many areas of application.
All types are indirectly heated.
Life test for most types is 10 000 h.
Base fitting depends on tube type:

- octal
- noval
- magnoval
- miniature 7 pin
- subminiature

Applications in:

- a.f. and r.f. amplifiers, frequencies up to 400 MHz
- oscillators
- wide-band output tubes for television equipment, etc.
- mixers
- stabilized d.c. power supplies
- output stage for video amplifiers
- telephone equipment

Triodes

For amplifiers, oscillators and multivibrators, etc.
All types are indirectly heated.
Base fitting depends on tube type:

- noval
- subminiature

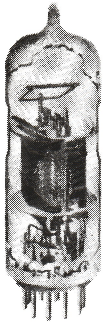
Double triodes

All types are indirectly heated.
Life test for most types is 10 000 h.
Many types have gold-plated pins.
Base fitting depends on tube type:

- noval
- miniature 7 to 10 pin

Applications in:

- h.f., i.f., a.f. and d.c. amplifiers
- cascade circuits
- mixers
- phase inverters
- multivibrators
- computer circuits



a.f. pentode E80F

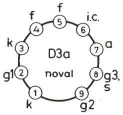
D3a
wide-band pentode

V_f = 6,3 V
I_f = 0,315 A

V_{ba} = 190 V
V_{bg2} = 160 V
V_{g3} = 0 V
V_{bg1} = +10 V

R_k = 400 Ω
I_a = 22 mA
I_{g2} = 6 mA
S = 35 mA/V

R_i = 120 kΩ
μ_{g2g1} = 80
R_{eq} = 150 Ω


f
f
i.c.
k
a
D3a
noval
g1
g3,
s
k
g2
1
2
3
4
5
6
7
8
9

DM160
computer indicator

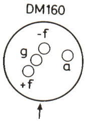
V_f = 1 V
I_f = 0,03 A

Operating

V_a = 50 V
R_g = 0,1 MΩ

V_{bg} = 0 V
I_a = 585 μA

V_{bg} = −3 V
I_a = <5 μA



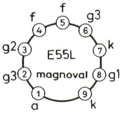
E55L
wide-band output pentode

V_f = 6,3 V
I_f = 0,6 A

V_a = 125 V
V_{g2} = 125 V
V_{g1} = −3 V

V_{g3} = 0 V
I_a = 50 mA
I_{g2} = 5,5 mA

S = 45 mA/V
R_i = 20 kΩ
μ_{g2g1} = 30
W_a = max 10 W


f
f
g3
g2
k
E55L
magnoval
g3
g1
a
k
1
2
3
4
5
6
7
8
9

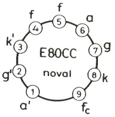
E80CC

V_f = 6,3 V
I_f = 0,6 A or
V_f = 12,6 V
I_f = 0,3 A

V_a = 250 V
R_k = 920 Ω

I_a = 6 mA
S = 2,7 mA/V

R_i = 10 kΩ
μ = 27


f
f
a
k'
g
E80CC
noval
g'
k
a'
f_c
1
2
3
4
5
6
7
8
9

E80CF

V_f = 6,3 V
I_f = 0,33 A

Pentode

V_{ba} = 170 V
V_{bg2} = 170 V
R_k = 155 Ω

I_a = 10 mA
I_{g2} = 2,8 mA
S = 6,2 mA/V

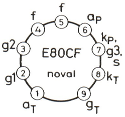
R_i = 0,4 MΩ
μ_{g2g1} = 40

Triode

V_{ba} = 100 V
R_k = 120 Ω

I_a = 14 mA
S = 5 mA/V

R_i = 3,6 kΩ
μ = 18


f
f
a_P
k_P,
g2
g3,
s
E80CF
noval
g1
k_T
a_T
g_T
1
2
3
4
5
6
7
8
9

E80F
a.f. pentode

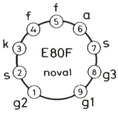
V_f = 6,3 V
I_f = 0,3 A

Operating

V_{ba} = 250 V
V_{bg2} = 250 V
R_a = 0,22 MΩ
R_{g2} = 1,2 MΩ

R_k = 1,5 kΩ
R_{g1} = 1 MΩ
$R_{g1'}$ = 0,68 MΩ

I_a = 0,8 mA
I_{g2} = 0,17 mA
V_o/V_i = 175


f
f
a
k
s
E80F
noval
s
g3
g2
g1
1
2
3
4
5
6
7
8
9

E80L

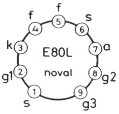
V_f = 6,3 V
I_f = 0,7 A

Operating as class-A power amplifier

V_a = 200 V
V_{g2} = 200 V
V_{g3} = 0 V
R_k = 130 Ω

I_a = 30 mA
I_{g2} = 4,1 mA

$R_{a\sim}$ = 7 kΩ
W_o = 2,7 W
d_t = 10%
W_a = max 8 W


f
f
s
k
a
E80L
noval
g1
g2
s
g3
1
2
3
4
5
6
7
8
9

E81L

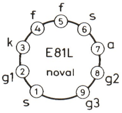
V_f = 6,3 V
I_f = 0,375 A

Operating as class-A power amplifier

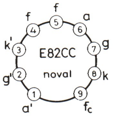
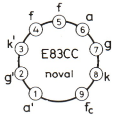
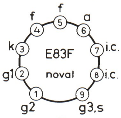
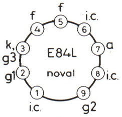
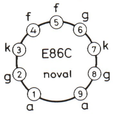
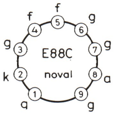
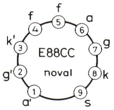
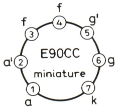
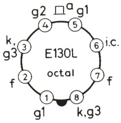
V_a = 210 V
V_{g2} = 210 V
V_{g3} = 0 V
R_k = 120 Ω

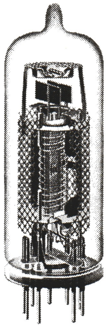
I_a = 20 mA
I_{g2} = 5,3 mA

$R_{a\sim}$ = 15 kΩ
W_o = 1 W
d_t = 5%
W_a = max 4,5 W

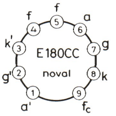
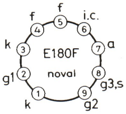
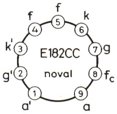
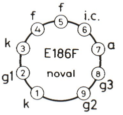
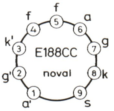
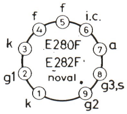
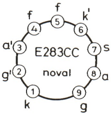
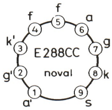
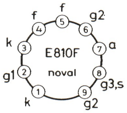

f
f
s
k
a
E81L
noval
g1
g2
s
g3
1
2
3
4
5
6
7
8
9

special quality tubes

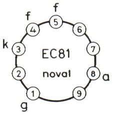
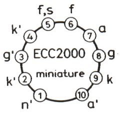
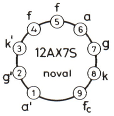
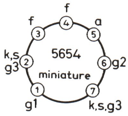
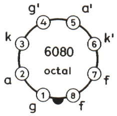
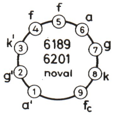
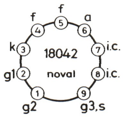
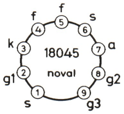
E82CC	V_f = 6,3 V I_f = 0,3 A or V_f = 12,6 V I_f = 0,15 A	V_a = 250 V R_k = 800 Ω	I_a = 10,5 mA S = 2,2 mA/V	R_i = 7,7 kΩ μ = 17	 f f a k' g E82CC noval g' k a' fc
E83CC	V_f = 6,3 V I_f = 0,3 A or V_f = 12,6 V I_f = 0,15 A	V_a = 250 V R_k = 1,6 kΩ	I_a = 1,25 mA S = 1,6 mA/V	R_i = 62,5 kΩ μ = 100	 f f a k' g E83CC noval g' k a' fc
E83F	V_f = 6,3 V I_f = 0,3 A	V_a = 210 V V_{g2} = 120 V V_{g3} = 0 V R_k = 165 Ω	I_a = 10 mA I_{g2} = 2,1 mA S = 9 mA/V	R_i = 0,5 MΩ μ_{g2g1} = 38 R_{eq} = 750 Ω	 f f a k i.c. E83F noval g1 i.c. g2 g3,s
E84L	V_f = 6,3 V I_f = 0,76 A	Operating as class-A power amplifier V_a = 250 V V_{g2} = 250 V R_k = 135 Ω	I_a = 48 mA I_{g2} = 5,5 mA	$R_{a\sim}$ = 4,5 kΩ W_o = 5,7 W d_t = 10% W_a = max 13,5 W	 f f i.c. k,g3 a E84L noval g1 i.c. i.c. g2
E86C u.h.f. triode	V_f = 6,3 V I_f = 0,165 A	V_{ba} = 185 V V_{bg} = +8 V R_k = 800 Ω	I_a = 12 mA S = 14 mA/V R_i = 4,8 kΩ	μ = 68 R_{eq} = 250 Ω f up to 800 MHz	 f f g k k E86C noval g g a a
E88C u.h.f. triode	V_f = 6,3 V I_f = 0,165 A	V_a = 160 V V_g = −1,25 V	I_a = 12,5 mA S = 13,5 mA/V R_i = 5,2 kΩ	μ = 70 R_{eq} = 240 Ω f up to 1000 MHz	 f f g g g E88C noval k a a g
E88CC	V_f = 6,3 V I_f = 0,3 A	V_{ba} = 100 V V_{bg} = +9 V R_k = 680 Ω	I_a = 15 mA S = 12,5 mA/V	μ = 33 R_{eq} = 300 Ω	 f f a k' g E88CC noval g' k a' s
E90CC double triode for computer application	V_f = 6,3 V I_f = 0,4 A	V_a = 100 V V_g = −2,1 V	I_a = 8,5 mA S = 6 mA/V	R_i = 4,5 kΩ μ = 27	 f f g' E90CC miniature a' g a k
E130L	V_f = 6,3 V I_f = 1,7 A	Operating as class-A power amplifier V_a = 250 V V_{g2} = 150 V V_{g1} = −15,5 V	I_a = 100 mA I_{g2} = 18 mA	$R_{a\sim}$ = 2,7 kΩ W_o = 11,5 W d_t = 10% W_a = max 27,5 W	 g2 a g1 k,g3 i.c. E130L octal f f g1 k,g3



Pentode E83F

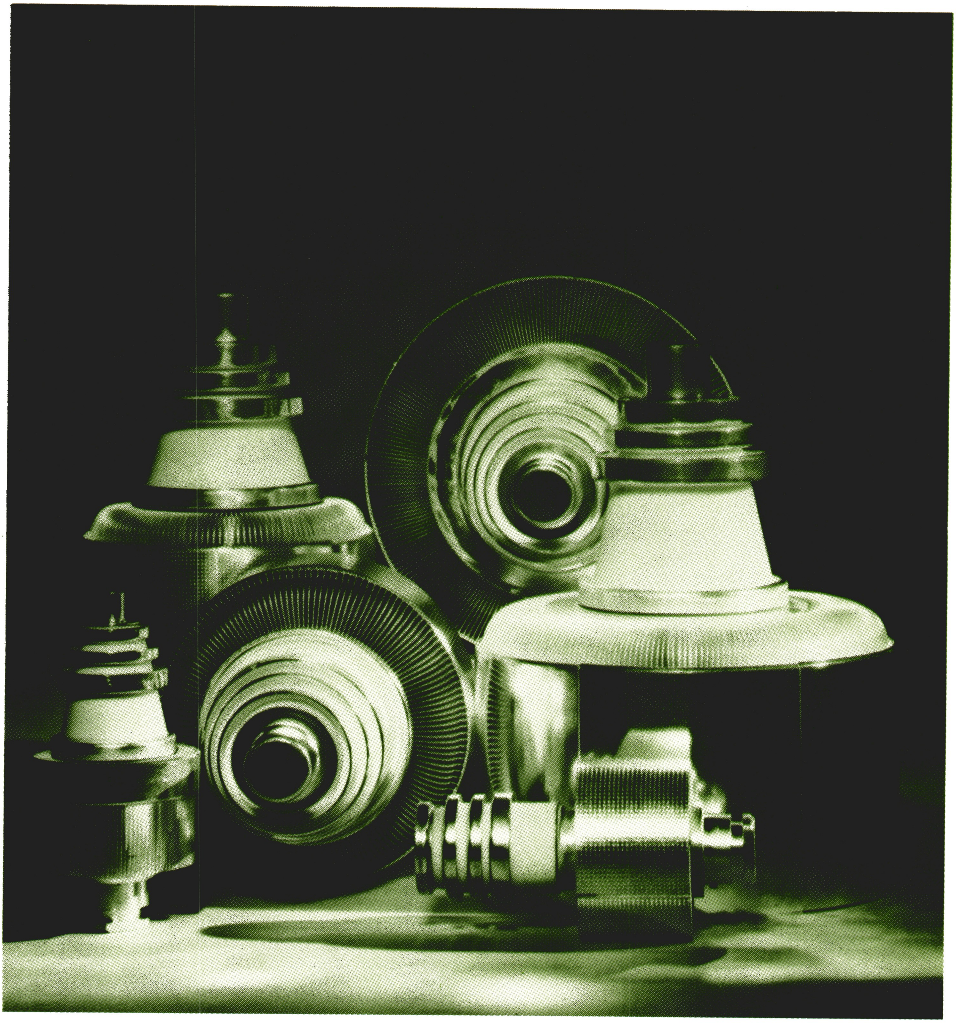
E180CC double triode for computer application	V_f = 6,3 V I_f = 0,4 A or V_f = 12,6 V I_f = 0,2 A	V_a = 150 V V_g = −1,85 V	I_a = 8,5 mA S = 6,4 mA/V	R_i = 7,2 kΩ μ = 46	 f f a k' E180CC g g' noval k a' f_c
E180F wide-band pentode	V_f = 6,3 V I_f = 0,3 A	V_{ba} = 190 V V_{bg2} = 160 V V_{g3} = 0 V V_{bg1} = +9 V	R_k = 630 Ω I_a = 13 mA I_{g2} = 3,3 mA S = 16,5 mA/V	R_i = 90 kΩ μ_{g2g1} = 50 R_{eq} = 330 Ω	 f f i.c. k E180F a g1 noval g3,s k g2
E182CC double triode for computer application	V_f = 6,3 V I_f = 0,64 A or V_f = 12,6 V I_f = 0,32 A	V_a = 120 V V_g = −2 V	I_a = 36 mA S = 15 mA/V	R_i = 1,6 kΩ μ = 24	 f f k k' E182CC g g' noval f_c a' a
E186F wide-band pentode	V_f = 6,3 V I_f = 0,32 A	V_{ba} = 190 V V_{bg2} = 160 V V_{g3} = 0 V V_{bg1} = +9 V	R_k = 630 Ω I_a = 13 mA I_{g2} = 3,3 mA S = 16,5 mA/V	R_i = 100 kΩ μ_{g2g1} = 53 R_{eq} = 330 Ω	 f f i.c. k E186F a g1 noval g3 k g2
E188CC	V_f = 6,3 V I_f = 0,335 A	V_{ba} = 100 V V_{bg} = +9 V R_k = 680 Ω	I_a = 15 mA S = 12,5 mA/V	μ = 33 R_{eq} = 250 Ω	 f f a k' E188CC g g' noval k a' s
E280F wide-band pentode	V_f = 6,3 V I_f = 0,315 A	V_{ba} = 190 V V_{bg2} = 160 V V_{g3} = 0 V V_{bg1} = +8 V	R_k = 370 Ω I_a = 20 mA I_{g2} = 6 mA S = 26 mA/V	R_i = 100 kΩ μ_{g2g1} = 60 R_{eq} = 220 Ω	 f f i.c. k E280F E282F a g1 noval g3,s k g2
E282F wide-band pentode	V_f = 6,3 V I_f = 0,35 A	V_{ba} = 125 V V_{bg2} = 125 V V_{g3} = 0 V V_{bg1} = +12 V	R_k = 300 Ω I_a = 35 mA I_{g2} = 11 mA	S = 26 mA/V μ_{g2g1} = 27 R_{eq} = 200 Ω	
E283CC a.f. double triode	V_f = 6,3 V I_f = 0,33 A	Operating V_{ba} = 250 V R_a = 47 kΩ R_k = 1,2 kΩ	I_a = 1,18 mA V_o/V_i = 37,5		 f f k' a' E283CC s g' noval a k g
E288CC r.f. double triode	V_f = 6,3 V I_f = 0,475 A	V_{ba} = 100 V V_{bg} = +9 V R_k = 350 Ω	I_a = 30 mA S = 20 mA/V R_i = 1,25 kΩ	μ = 25 R_{eq} = 200 Ω	 f f a k' E288CC g g' noval k a' s
E810F wide-band pentode	V_f = 6,3 V I_f = 0,34 A	V_{ba} = 135 V V_{bg2} = 165 V V_{g3} = 0 V V_{bg1} = +12,5 V	R_k = 360 Ω I_a = 35 mA I_{g2} = 5 mA S = 50 mA/V	R_i = 42 kΩ μ_{g2g1} = 57 R_{eq} = 110 Ω	 f f g2 k E810F a g1 noval g3,s k g2

special quality tubes

EC81 u.h.f. osc. triode	V_f = 6,3 V I_f = 0,175 A	V_a = 150 V V_g = −2 V	I_a = 30 mA S = 5,5 mA/V	μ = 16 f up to 750 MHz	 f f k EC81 noval a g
ECC2000 v.h.f. double triode	V_f = 6,3 V I_f = 0,335 A	V_a = 90 V V_g = −1,4 V $V_{a'}$ = 90 V $V_{g'}$ = −1,4 V $V_{Sn'}$ = 0 V	I_a = 27 mA S = 22 mA/V I_a = 27 mA S = 17,5 mA/V	μ = 28 R_{eq} = 150 Ω μ = 27 R_{eq} = 200 Ω	 f,s f k' a g' ECC2000 g k' miniature k n' a'
12AX7S a.f. double triode	V_f = 6,3 V I_f = 0,3 A or V_f = 12,6 V I_f = 0,15 A	V_a = 250 V V_g = −2 V	I_a = 1,2 mA S = 1,6 mA/V	R_i = 62,5 kΩ μ = 100	 f f a k' 12AX7S g g' noval k a' f_c
5654 wide-band pentode	V_f = 6,3 V I_f = 0,175 A	V_a = 120 V V_{g2} = 120 V V_{g1} = −2 V	I_a = 7,5 mA I_{g2} = 2,5 mA	S = 5 mA/V R_i = 0,34 MΩ	 f f a k,s g3 5654 miniature g2 g1 k,s,g3
6080 double triode series reg.	V_f = 6,3 V I_f = 2,5 A	V_a = 100 V R_k = 300 Ω	I_a = 100 mA S = 6,5 mA/V	R_i = 300 Ω μ = 2 W_a = max. 13 W	 g' a' k 6080 k' octal a f g f
6189 double triode	I_f = 6,3 V I_f = 0,3 A or V_f = 12,6 V I_f = 0,15 A	V_a = 250 V V_g = −8,5 V	I_a = 10,5 mA S = 2,2 mA/V	μ = 17	 f f a k' 6189 6201 g g' noval k a' f_c
6201 double triode	V_f = 6,3 V I_f = 0,3 A or V_f = 12,6 V I_f = 0,15 A	V_a = 250 V R_k = 200 Ω	I_a = 10 mA S = 5,5 mA/V	R_i = 10,9 kΩ μ = 60	
18042 pentode	V_f = 18 V I_f = 0,1 A	V_a = 210 V V_{g2} = 120 V V_{g3} = 0 V R_k = 165 Ω	I_a = 10 mA I_{g2} = 2,1 mA S = 9 mA/V	R_i = 0,5 MΩ μ_{g2g1} = 38 R_{eq} = 750 Ω	 f f a k 18042 i.c. g1 noval i.c. g2 g3,s
18045 output pentode	V_f = 18 V I_f = 0,13 A	Operating as class-A power amplifier V_a = 210 V V_{g2} = 210 V V_{g3} = 0 V R_k = 120 Ω	I_a = 20 mA I_{g2} = 5,3 mA S = 11 mA/V	$R_{a\sim}$ = 15 kΩ μ_{g2g1} = 36 W_o = 1 W d_t = 5% W_a = max 4,5 W	 f f s k 18045 a g1 noval g2 s g3

transmitting tubes

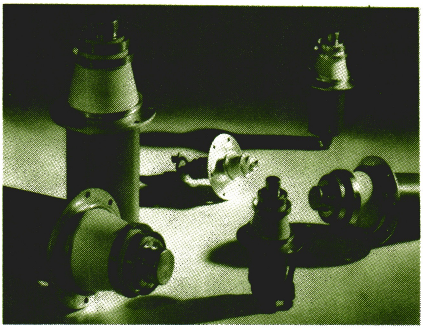
For detailed information
Handbook ET1a and 1b



tubes for r.f. heating

COOLING:
FA = forced air
N = natural
W = water
WH = water (helix)
V = vapour
H = heatsink

type	status	oscillator output power kW	cooling	frequency at full ratings max. MHz	V_f V	I_f A	V_a kV	I_a A	V_a max. kV	W_a max. kW	h x dia. max. mm
TBL2/300	C	0,27	FA	470	3,4	19	1,75	0,34	1,8	0,3	72 x 41,5
TB2.5/300 TB2.5/400	C	0,29	N	40 50	6,3	5,4 5,8	2	0,17	2,5 2,7	0,135 0,15	133 x 62
TBL2/400	C	0,34	FA	470	3,4	19	2	0,38	2,2	0,4	83 x 41,5
TB3/750	C	0,9	N	50	5	14,1	3,5	0,325	3,8	0,35	151 x 87
TB4/1250	C	1,55	N	100	10	9,9	4	0,535	4	0,45	213 x 118
TB4/1500	C	1,58	N	50	5	32,5	5	0,43	7	0,5	240 x 130
YD1240	D	2,67	FA	250	6,3	33	5	0,75	5,5	1,5	172 x 67
TB5/2500	C	2,73	N	50	6,3	32,5	6	0,6	7	0,8	256 x 155
YD1350S YD1352S	D	3	FA WH	30 5	5	6,1	5	0,8	5	1,2 2	165 x 78 165 x 41,7
TBL6/4000	C	4	FA	50	6,3	65	7	0,9	8	1,7	177,5 x 86
YD1150 YD1151 YD1152	D	4,75	FA W WH	85	6,3	33	5	1	7,2	2,5	172 x 122,8 172 x 62 207 x 131
TBH7/8000 TBL7/8000 TBW7/8000	C	6	WH FA W	50	12,6	33	6	1,5	7	6	219 x 130 195 x 122,6 190 x 70,5
TBH6/6000 TBL6/6000 TBW6/6000	C	6,9	WH FA W	50	12,6	33	6	1,5	6	6 5 6	219 x 130 195 x 122,6 190 x 70,5
TBH7/9000 TBL7/9000 TBW7/9000	C	7,2	WH FA W	50	12,6	33	7,2	1,5	8	6	211 x 130 186 x 122,6 224 x 86
YD1160 YD1161 YD1162	D	8,8	FA W WH	85	6,3	66	6,5	1,8	7,2	5	192 x 122,8 192 x 62 227 x 131
YD1173	D	13,2	FA	50	5,4	65	10	1,75	12	10	219 x 159,7



type	status	oscillator output power kW	cooling	frequency at full ratings max. MHz	V_f V	I_f A	V_a kV	I_a A	V_a max. kV	W_a max. kW	h x dia. max. mm
YD1170	D	**15,4**	FA	120	5,8	130	6	3,4	7,2	10	219 x 159,7
YD1172			WH								219 x 115
TBH6/14	C	**17,7**	WH	30	6,3	136	7	3,5	8	15	351 x 185
TBL6/14			FA							10	315 x 163
TBW6/14			W							15	330 x 163
YD1412S	D	**30**	W	5	7	12	10	4	12	15	270 x 72
TBH12/25	C	**25**	WH	30	8	98	12	3,2	13	15	410 x 185
TBL12/25			FA							15	378 x 198
TBW12/25			W							20	376 x 190
YD1175	D	**26,2**	FA	120	5,8	130	10	3,4	12	10	219 x 159,7
YD1177			WH							15	240 x 131
TBH12/38	C	**30**	WH	30	8	130	12	4,5	13	20	422 x 190
TBL12/38			FA							15	404 x 192
TBW12/38			W							20	422 x 190
YD1180	D	**31,6**	FA	100	7	175	7,5	5,4	9	15	242,5 x 192
YD1182			WH							20	272,5 x 130,5
YD1185	D	**50**	FA	100	7	175	12	5,33	14,4	15	241,5 x 191
YD1186			FA							15	241,5 x 191
YD1187			WH							20	290 x 130,5
YD1192	D	**62,7**	WH	100	8,4	235	8	10	9,6	40	360 x 160,5
YD1195	D	**90**	FA	30	8,4	235	12	9,75	14,4	30	290 x 216
YD1197	D	**108**	WH	30	8,4	235	12	12	15	50	360 x 160,5
YD1140	C	**124**	W	30	17,5	196	12	14	13	100	620 x 240
YD1141			FA							45	660 x 286
YD1202	D	**163**	WH	30	12,2	250	12	18	15	80	465 x 191
YD1212	D	**240**	WH	30	12,6	380	14	23,5	16,8	120	465 x 191
YD1342	D	**480**	WH	30	14	555	16	42	19,5	240	610 x 230

transmitting tubes

telegraphy and f.m. broadcast service

COOLING:

FA = forced air

N = natural

W = water

WH = water (helix)

V = vapour

H = heatsink

Triodes — class C

type	status	output power kW	cooling	frequency at full ratings max. MHz	V_f V	I_f A	V_a kV	I_a A	V_a max. kV	W_a max. kW	h x dia. max. mm
TB2.5/300	C	**0,39**	N	75	6,3	5,4	2,5	0,2	2,5	0,135	132 x 62
TB2.5/400		**0,39**	N	150	6,3	5,8	2,5	0,2	3	0,15	132 x 62
TBL2/300		**0,48**	FA	175	3,4	19	2,5	0,26	2,5	0,3	72 x 41,5
TBL2/400		**0,6**	FA	900	3,4	19	2	0,4	2,2	0,4	83 x 41,5
TBL2/500		**0,67**	FA	400	3,4	19	2,5	0,38	2,7	0,5	83 x 41,5
TB3/750	C	**1,2**	N	100	5	14,1	4	0,38	4	0,35	151 x 87
TB4/1250		**1,69**			10	9,9		0,54		0,45	213 x 118
TBH6/6000	C	**6,9**	WH	75	12,6	33	6	1,5	6	6	219 x 130
TBL6/6000			FA							5	195 x 122,6
TBW6/6000			W							6	190 x 70,5
TBL7/8000	C	**9,5**	FA	30	12,6	33	6,5	2	7,2	6	195 x 122,6
TBW7/8000			W								190 x 70,5
TBL6/20	M	**17**	FA	110	6,3	154	5	4,8	5,5	10	277 x 169,5
TAW12/20	M	**22**	W	28	21,5	80	12	2,7	12	18	578 x 163
TBL12/40	C	**41**	FA	30	8	130	12	4,5	13	15	404 x 225
TBL12/100	M	**108**	FA	15	17,5	196	12	12	13,5	45	660 x 286
TBW12/100			W							50	620 x 240
YD1140	C	**108**	W	30	17,5	196	12	12	15	100	620 x 240
YD1141			FA							45	660 x 286
YD1000	C	**120**	W	10	12,6	160	15	9,8	16	45	380 x 140
YD1001			FA							35	380 x 300
YD1002			V							60	380 x 218
YD1010	C	**360**	W	10	18	280	15	29,3	15	120	656 x 218
YD1012			V							180	650 x 315

Tetrodes

type	status	output power W	cooling	frequency at full ratings max. MHz	V_f V	I_f A	V_a kV	V_{g2} V	I_a mA	V_a max. kV	W_a max. W	h x dia. max. mm
QE05/40 **QE05/40F** **QE05/40H** **QE05/40K**	M	**52**	N	60	6,3 12,6 26,5 13,5	1,25 0,625 0,3 0,585	0,6	150	112	0,6	20	97 x 44 96 x 44 97 x 44 96,8 x 42,1
YL1250	M	**52**	N	75	6,75 13,5	1,2 0,6	0,55	235	136	0,55	25	59 x 44,5
YL1370 **YL1371** **YL1372**	M	**63**	N	60	6,3 12,6 26,5	1,125 0,562 0,3	0,6	200	150	0,6	27	96 x 44
QC05/35	M	**65**	N	60	1,6	3,2	0,6	180	150	0,65	25	97 x 44
YL1100 **YL1101**	M	**80**	FA	1200	26,5 6,3	0,52 2,1	0,9	300	170	1	115	49,6 x 32,2
QB3/200	C	**280**	N	50	6	3,5	3	250	115	3	65	111 x 60,5
QE08/200 **QE08/200H**	C	**290**	N	30	6,3 26,5	3,9 0,85	1	250	385	1,1	100	150 x 72
QEL1/150 **QEL1/150H**	C	**370**	FA	150	6 26,5	2,6 0,58	2	250	250	2	250	62,7 x 41,7
7609	C	**370**	FA	150	26,5	0,58	2	250	250	2	250	62,7 x 41,7
QB3/300 **QB3/300GA**	C	**375**	N	120	5	6,5	3	350	167	3	125	130,8 x 62 144 x 69,1
QEL2/275 **QEL2/275H**	C	**390**	FA	500	6 26,5	2,6 0,58	2	250	250	2	250	62,7 x 41,7
YL1110	M	**730**	FA	1215	6,3	7,85	2,5	400	500	2,5	700	61 x 53,1
QBL4/800	C	**930**	FA	120	5	13,5	4	500	315	4	500	120 x 67
QB3.5/750 **QB3.5/750GA**	C	**1000**	N	75	5	14,1	4	500	310	4	250	151,8 x 87 161 x 87
QB4/1100 **YL1460**	C	**1100**	N	110	5	14,1	4	500	350	4	400	151,5 x 100

transmitting tubes

telegraphy and f.m. broadcast service

COOLING: FA = forced air
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WH = water (helix)
V = vapour
H = heatsink

Tetrodes (cont.)

type	status	output power W	cooling	frequency at full ratings max. MHz	V_f V	I_f A	V_a kV	V_{g2} V	I_a mA	V_a max. kV	W_a max. W	h x dia. max. mm
QB4/1100GA YL1461	C	**1100**	N	110	5	14,1	4	500	350	4	400	161 x 87
QB5/1750	C	**1760**	N	75	10	9,9	5	600	440	5	500	209 x 118
QBL3.5/2000		**2100**	FA	1000	3,6	58	4,3	600	850	4,5	1500	215 x 89
YL1540	D	**2200**	FA	260	4,2	53	4	700	1200	4,2	1800	122 x 63
QB5/2000	C	**2400**	N	30	7,5	22,6	5	600	600	5,5	800	248 x 153
YL1440	D		FA	260	4,2	53	3		980	4	1500	125 x 63
QBL5/3500	C	**4100**	FA	75	6,3	32,5	5	800	1100	5	3 kW	169 x 97
QBW5/3500			W									160 x 70,5
YL1420	D	**11 kW**	FA	260	6,3	120	7	600	2300	8,5	6 kW	174 x 125,1
YL1470											8 kW	
YL1430	D	**18 kW**	FA	260	8	120	8	700	3500	9,5	12 kW	211 x 164,2
YL1520	D	**25 kW**	FA	260	11,5	120	8,5	700	4600	9,5	18 kW	225 x 164,2

Pentodes

type	status	output power W	cooling	frequency at full ratings max. MHz	V_f V	I_f A	V_a V	V_{g2} V	I_a mA	V_a max. V	W_a max. W	h x dia. max. mm
PE06/40E					12,6	0,65						146 x 51
PE06/40N	M	**45**	N	20	6,3	1,3	600	300	110	600	25	146 x 51
PE06/40P					6,3	1,3						134 x 51
PE1/100	C	**132**	N	60	12,6	1,3	1000	250	177	1000	45	100 x 47

YL1470

Double tetrodes

type	status	output power W	cooling	frequency at full ratings max. MHz	V_f V	I_f A	V_a V	V_{g2} V	I_a mA	V_a max. V	W_a max. W	h x dia. max. mm
QQE02/5	M	**5,8**	N	500	6,3 12,6	0,6 0,3	180	180	27,5	250	3	66,7 x 22
YL1220	M	**5,8**	N	500	6,75 13,5	0,56 0,28	180	180	27,5	250	3	66,7 x 22
QQE04/5	M	**7**	N	960	6,3 12,6	0,6 0,3	250	160	35	400	8	63 x 44,5
YL1360	M	**7**	N	960	13,5	0,28	250	160	35	400	8	63 x 44,5
QQC03/14 [1]	M	**11**	N	200	3,15	1,65	250	160	45	300	7	77,8 x 22
QQE03/12	M	**12**	N	200	6,3 12,6	0,82 0,41	300	175	37,5	300	5	78 x 22
YL1210	M	**12**	N	200	6,75 13,5	0,72 0,36	300	175	37,5	300	5	78 x 22
YL1130 [1]	M	**13**	N	200	1,1	2,9	275	170	42,5	300	4	72,9 x 22
YL1240	M	**21**	N	200	6,75 13,5	0,8 0,4	400	180	45	400	7,5	82,7 x 30,1
QQE04/20	M	**26**	N	200	6,3 12,6	1,6 0,8	750	200	24	750	7,5	84 x 51
YL1190 [1]	M	**26**	N	200	1,1	4,2	350	132	70	400	8	73,9 x 30,2
QQC04/15 [1]	M	**26,6**	N	186	3,15 6,3	1,36 0,68	600	200	30	600	6	100 x 32
YL1020 [1]	M	**35**	N	200	1,6	4	600	250	50	600	10	86 x 46
YL1030 [1]	M	**45**	N	200	2,1	4,5	400	250	100	750	20	106 x 46
QQE03/20 QQE03/32	M	**48**	N	200	6,3 12,6	1,3 0,65	600	250	50	600	10	85,5 x 46
QQE06/40	M	**90**	N	250	6,3 12,6	1,8 0,9	600	250	100	750	20	108,5 x 49
YL1060	M	**132**	N	175	6,3 12,6	1,8 0,9	900	245	110	1000	30	103 x 44,6

[1] Quick heating.

transmitting tubes

a.m. broadcast service

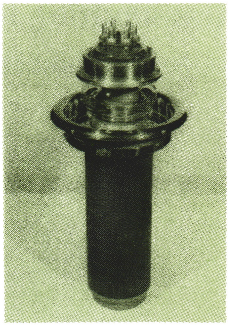
COOLING:
FA = forced air **W = water** **V = vapour**
N = natural **WH = water (helix)** **H = heatsink**

Triodes — r.f. class C modulation

type	status	output power kW	cooling	frequency at full ratings max. MHz	V_f V	I_f A	V_a kV	I_a A	V_a max. kV	W_a max. kW	h x dia. max. mm
TB2.5/300	C	**0,204**	N	75	6,3	5,4	2	0,128	2,5	0,135	132,8 x 62
TB2.5/400		**0,205**	N	150	6,3	5,8	2	0,128	2,4	0,1	132 x 62
TBL2/300		**0,505**	FA	175	3,4	19	2	0,335	2	0,2	72 x 41,5
TB4/1250		**1,05**	N	100	10	9,9	3	0,45	3	0,3	213 x 118
TBL6/6000	C	**4,7**	FA	75	12,6	33	5	1,2	5	4	195 x 122,6
TBW6/6000			W								190 x 70,5
TAW12/20	M	**9,5**	W	28	21,5	80	10	1,4	12	18	578 x 163
TBL12/40	C	**27,5**	FA	30	8	130	10	3,5	10	10	404 x 225
YD1000	C	**66**	W	30	12,6	160	11	7,6	11,5	30	380 x 140
YD1001			FA								380 x 300
YD1002			V								380 x 218
TBL12/100	M	**80**	FA	15	17,5	196	10	10,5	10	30	660 x 286
TBL15/125				80							
TBW12/100	M	**80**	W	15	17,5	196	10	10,5	10	30	620 x 240
TBW15/125											
YD1140	C	**83**	W	30	17,5	196	10	10,5	10,5	66	620 x 240
YD1141			FA							30	660 x 286
YD1010	C	**165**	W	30	18	280	11	19	11	80	656 x 218
YD1012										120	650 x 315

Pentodes — r.f. class C anode and screen-grid modulation

type	status	output power W	cooling	frequency at full ratings max. MHz	V_f V	I_f A	V_a V	V_{g2} V	I_a mA	V_a max. V	W_a max. W	h x dia. max. mm
PE06/40E	M	**40**	N	20	12,6	0,65	500	100	114	600	25	146 x 51
PE06/40N					6,3	1,3						146 x 51
PE06/40P					6,3	1,3						134 x 51
PE1/100	C	**75**	N	60	12,6	1,3	800	250	120	1000	45	108 x 47



TBL12/100

Tetrodes — r.f. class C anode and screen-grid modulation

type	status	output power W	cooling	frequency at full ratings max. MHz	V_f V	I_f A	V_a kV	V_{g2} V	I_a mA	V_a max. kV	W_a max. W	h x dia. max. mm
QC05/35	M	**34**	N	60	1,6	3,2	0,475	135	94	0,48	14	97 x 44
QE05/40 **QE05/40F** **QE05/40H** **QE05/40K**	M	**34**	N	60	6,3 12,6 26,5 13,5	1,25 0,625 0,3 0,58	0,475	135	94	0,48	13,3	97 x 44
YL1370 **YL1371** **YL1372**	M	**42**	N	60	6,3 12,6 26,5	1,125 0,562 0,3	0,475 0,475	165	125	0,48	18	96 x 44
YL1100 **YL1101**	M	**45**	FA	1200	26,5 6,3	0,52 2,1	0,7	250	130	0,8	75	49,6 x 32,2
QE08/200 **QE08/200H**	C	**130**	N	30	6,3 26,5	3,9 0,85	0,6	250	300	0,65	67	150 x 72
QB3/200	C	**230**	N	150	6	3,5	2,5	250	110	2,5	45	111 x 60,5
QEL1/150 **QEL1/150H**	C	**230**	FA	150	6 26,5	2,6 0,58	1,6	250	200	1,6	165	62,7 x 41,7
7609	C	**230**	FA	150	26,5	0,58	1,6	250	200	1,6	165	62,7 x 41,7
QEL2/275 **QEL2/275H**	C	**235**	FA	500	6 26,5	2,6 0,58	1,5	250	200	1,5	165	62,7 x 41,7
QB3/300 **QB3/300GA**	C	**300**	N	120	5	6,5	2,5	350	152	2,5	83	130,8 x 64 144 x 69,1
QB3.5/750 **QB3.5/750GA**	C	**510**	N	75	5	14,1	3	400	225	3,2	165	151,8 x 87 161 x 87
YL1110	M	**600**	FA	1215	6,3	7,85	2	400	500	2	400	61 x 53,1
QB4/1100GA **YL1461**	C	**630**	N	75	5	14,1	3	500	275	3,2	270	151,5 x 100
QB4/1100 **YL1460**	C	**630**	N	75	5	14,1	3	500	275	3,2	270	161 x 87
QB5/1750	C	**1200**	N	75	10	9,9	4	600	380	4	330	209 x 118
QBL5/3500 **QBW5/3500**	C	**2700**	FA W	110	6,3	32,5	4	800	900	4	2000	169 x 97 160 x 70,5
YL1010 **YL1012**	C	**55 kW**	W V	30	10	200	10	800	7,4 A	10	20 kW 30 kW	306,5 x 140 315 x 218

transmitting tubes

a.m. broadcast service

COOLING:
FA = forced air
N = natural
W = water
WH = water (helix)
V = vapour
H = heatsink

Double tetrodes — r.f. class C anode and screen-grid modulation

type	status	output power W	cooling	frequency at full ratings max. MHz	V_f V	I_f A	V_a V	V_{g2} V	I_a mA	V_a max. V	W_a max. W	h x dia. max. mm
QQE02/5	M	**3,5**	N	500	6,3 12,6	0,6 0,3	180	180	20	200	2	66,7 x 22
YL1220	M	**3,5**	N	500	6,75 13,5	0,56 0,28	180	180	20	200	2	66,7 x 22
QQE03/12	M	**7,1**	N	200	6,3 12,6	0,82 0,41	200	175	33,5	240	3,3	78 x 22
YL1210	M	**7,1**	N	200	6,75 13,5	0,72 0,36	200	175	33,5	240	3,3	78 x 22
YL1020 [1]	M	**13**	N	200	1,6	4	300	250	40	500	7	86 x 46
YL1240	M	**13,5**	N	200	6,75 13,5	0,8 0,4	320	140	37,5	320	5	82,7 x 30,1
YL1190 [1]	M	**15**	N	200	1,1	4,2	280	150	50	330	5,5	73,9 x 30,1
QQE04/20	M	**17**	N	200	6,3 12,6	1,6 0,8	600	200	18	600	5	84 x 51
QQC04/15	M	**17,5**	N	186	3,15 6,3	1,36 0,68	450	200	25	480	4	100 x 32
QQE03/20 **QQE03/32**	M	**31**	N	200	6,3 12,6	1,3 0,65	500	250	40	500	10	85,5 x 46
YL1030 [1]	M	**32**	N	200	2,1	4,5	400	250	75	600	14	106 x 46
QQE06/40	M	**71**	N	250	6,3 12,6	1,8 0,9	600	250	75	600	14	108,5 x 49
YL1060	M	**85**	N	175	6,3 12,6	1,8 0,9	750	250	90	800	21	103 x 44,6

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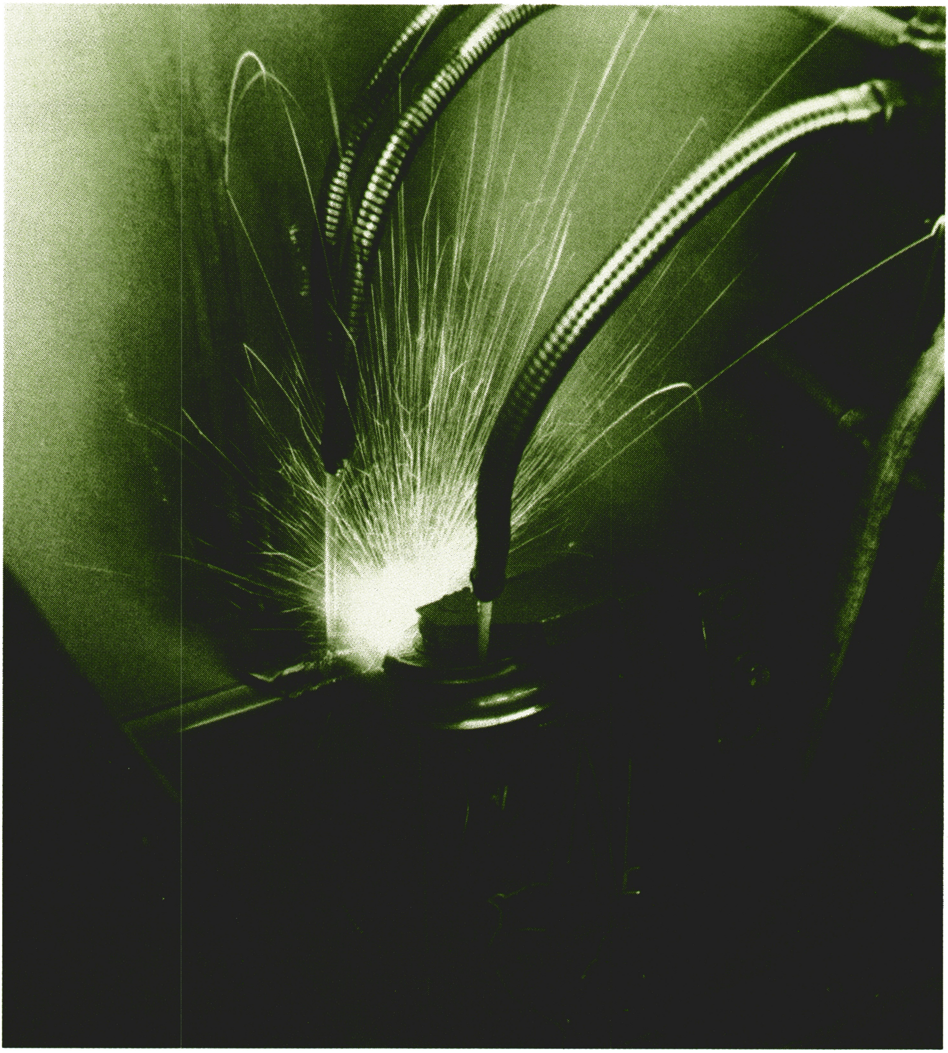
[1] Quick heating.

A single YD1202 supplies the r.f. heating coil of this induction welding machine, which makes pipes from flat strip. (Courtesy of Neirotti s.p.a., Villa Nova d'Asti, Italy.)



transmitting tubes

a.f. modulator service - two tubes

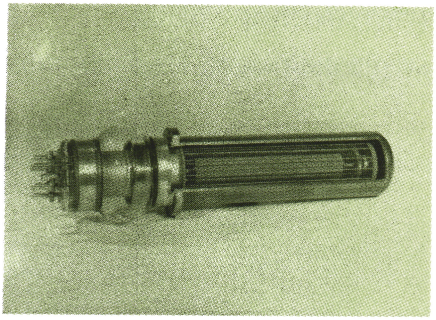
COOLING: FA = forced air   W = water   V = vapour
N = natural   WH = water (helix)   H = heatsink

Triodes

type	status	output power kW	cooling	V_f V	I_f A	V_a kV	I_a A	V_a max. kV	W_a max. kW	h x dia. max. mm
TB2.5/300	C	**0,7**	N	6,3	5,4	2,5	0,356	2,5	0,135	132 x 62
TB2.5/400		**0,7**		6,3	5,8	2,5	0,356	3	0,15	132 x 62
YD1130		**1,31**		5	14,1	3	0,666	3	0,4	151,5 x 87
TB3/750		**1,55**		5	14,1	4	0,54	4	0,35	151 x 87
TB4/1250		**2,29**		10	9,9	4	0,736	4	0,45	213 x 118
TBL6/6000	C	**13,3**	FA	12,6	33	6	3	6	5	195 x 122,6
TBW6/6000		**13,3**	W	12,6	33	6	3	6	6	190 x 70,5
TBL12/40		**19,2**	FA	8	130	10	3,2	13	15	404 x 225
TBL7/8000	C	**20**	FA	12,6	33	7	4	7,2	6	195 x 122,6
TBW7/8000			W							190 x 70,5
TAW12/20	M	**42**	W	21,5	78	12	49	12	18	578 x 163
YD1000	C	**78**	W	12,6	160	12	9,5	12	45	380 x 140
YD1001			FA		12,6				35	380 x 300
YD1002			V		12,6				60	380 x 218
YD1140	C	**106**	W	17,5	196	10	16	15	100	620 x 240
YD1141			FA						45	660 x 286
TBL12/100	M	**202**	FA	17,5	196	12	24	15	45	660 x 286
TBL15/125										
TBW12/100	M	**202**	W	17,5	196	12	24	15	50	620 x 240
TBW15/125										
YD1012	C	**450**	V	18	280	12	52	12	180	650 x 315

Pentode

type	status	output power W	cooling	V_f V	I_f A	V_a kV	V_{g2} V	I_a A	V_a max. kV	W_a max. W	h x dia. max. mm
PE1/100	C	**194**	N	12,6	1,3	1	250	0,268	1	45	108 x 47



TBW12/100

Tetrodes

type	status	output power W	cooling	V_f V	I_f A	V_a kV	V_{g2} V	I_a mA	V_a max. kV	W_a max. W	h x dia. max. mm
QE05/40 **QE05/40F** **QE05/40H** **QE05/40K**	M	**90**	N	6,3 12,6 26,5 13,5	1,25 0,625 0,3 0,585	0,6	165	206	0,6	20	97 x 44
YL1150	C	**200**	N	6,3 12,6	1,9 0,95	0,6	250	520	0,75	75	125,5 x 51
QB3/200	C	**270**	N	6	3,5	1,8	250	220	3	65	111 x 60,5
QB3/300 **QB3/300GA**	C	**550**	N	5	6,5	2,5	350	302	3	125	130,8 x 62 144 x 69,1
QEL2/275 **QEL2/275H**	C	**600**	FA	6 26,5	2,6 0,58	2	350	500	2	250	62,7 x 41,7
7609	C	**630**	FA	26,5	0,58	2	300	500	2	250	62,7 x 41,7
QEL1/150 **QEL1/150H**	C	**630**	FA	6 26,5	2,6 0,58	2	300	500	2	250	62,7 x 41,7
YL1340 **YL1341**	C	**770**	FA	6 26,5	3,2 0,73	2,2	400	580	2,5	350	62,7 x 41,7
QB3.5/750GA **QBL3.5/2000**	C	**1,24 kW**	N	5	14,1	3	300	550	4	250	151,8 x 87 161 x 87
QB5/1750	C	**2,22 kW**	N	10	9,9	5	600	580	5	500	209 x 118
QBL5/3500 **QBW5/3500**	C	**9,5 kW**	N W	6,3	32,5	5	800	2,92 A	5	3 kW	169 x 97 160 x 70,5
YL1091	C	**320 kW**	V	20	345	11	1500	44 A	12	150 kW	532 x 315

Double tetrodes

QQE03/12	M	**17,5**	N	6,3 12,6	0,82 0,41	0,3	200	100	0,3	14	78 x 22
QQC04/15	M	**18**	N	3,15 6,3	1,36 0,68	0,45	200	65	0,6	12	100 x 32
QQE03/20 **QQE03/32**	M	**23,5**	N	6,3 12,6	1,3 0,65	0,5	250	73	0,6	20	85,5 x 46
QQE06/40	M	**86**	N	6,3 12,6	1,8 0,9	0,6	250	200	0,6	40	108,5 x 49

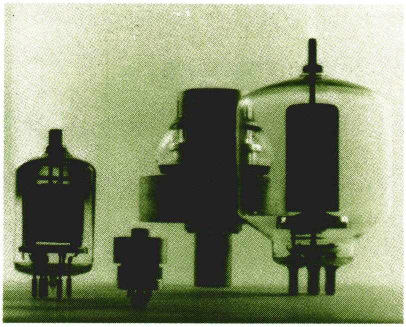
transmitting tubes

single side-band amplifier service

COOLING:
FA = forced air **W = water** **V = vapour**
N = natural **WH = water (helix)** **H = heatsink**

Tetrodes

type	status	output power P.E.P. W	cooling	frequency at full ratings max. MHz	V_f V	I_f A	V_a kV	V_{g2} V	I_a mA	V_a max. kV	W_a max. W	h x dia. max. mm
YL1100 **YL1101**	M	**40**	FA	1200	26,5 6,3	0,52 2,1	0,85	300	100	1	115	49,6 x 32,2
YL1370 **YL1371** **YL1372**	M	**49**	N	30	6,3 12,6 26,5	1,125 0,562 0,3	0,6	200	125	0,6	27	96 x 44
QB3/200	C	**87**	N	30	6	3,5	2,5	405	70	3	65	111 x 60,5
YL1150	C	**111**	N	60	6,3 12,6	1,9 0,95	0,6	250	325	0,75	75	125,5 x 51
QE08/200 **QE08/200H** **YL1290**	C	**220**	N	30	6,3 26,5 19	3,9 0,85 2,3	0,75	310	270	0,825	100	150 x 72
QEL1/150 **QEL1/150H**	C	**300**	FA	500	6 26,5	2,6 0,58	2	300	250	2	250	62,7 x 41,7
QEL2/275 **QEL2/275H**	C	**300**	FA	500	6 26,5	2,6 0,58	2	350	250	2	250	62,6 x 41,7
YL1340 **YL1341**	C	**318**	FA	175	6 26,5	3,2 0,73	2,2	300	215	2,5	350	62,6 x 41,7
QEL2/200	M	**400**	FA	500	6	2,6	2	400	350	2	250	62,6 x 41,7
8621	M	**436**	FA	500	25,6	0,56	2	350	310	2	250	62,6 x 41,7
QB3.5/750 **QB3.5/750GA**	C	**510**	N	30	5	14,1	4	550	180	4	275	151,8 x 87 161 x 87
QB4/1100 **QB4/1100GA**	C	**650**	N	110	5	14,1	4	705	250	4	400	151,5 x 100 161 x 87
YL1110	**M**	**680**	FA	1215	6,3	7,85	2,5	450	350	2,5	600	61 x 53,1
QB5/1750	C	**900**	N	30	10	9,9	5	700	280	5	500	209 x 118



Tubes for s.s.b.

Tetrodes (cont.)

type	status	output power P.E.P. kW	cooling	frequency at full rating max. MHz	V_f V	I_f A	V_a kV	V_{g2} V	I_a A	V_a max. kV	W_a max. kW	h x dia. max. mm
QB5/2000	C	**1,3**	N	30	7,5	22,6	4	600	0,465	5,5	0,8	248 x 153
YL1181 **YL1182**	C	**3**	FA V	30	5	64	4,5	800	1,33	6	4	178 x 100 178 x 122
QBL5/3500 **QBW5/3500**	C	**4,4**	N W	30	6,3	32,5	5	800	1,3	5	3	169 x 97 160 x 70,5
YL1120	M	**5,1**	FA	60	12,6	14,5	5	700	1,8	5,5	4	202 x 159
YL1010 **YL1011** **YL1012**	C	**33**	W FA V	30	9	200	10	1200	5,9	12	30 30 45	306,5 x 140 321,5 x 215 315 x 218
YL1091	C	**120**	V	30	20	345	9	1500	21	15	150	532 x 315

Double tetrodes

type	status	output power W	cooling	frequency at full ratings max. MHz	V_f V	I_f A	V_a kV	V_{g2} V	I_a mA	V_a max. kV	W_a max. W	h x dia. max. mm
YL1070	D	**141**	N	7	6,3 12,6	1,8 0,9	1	250	131	1	30	103,8 x 44,6
YL1071	D	**141**	H	7	13,25 26,5	0,866 0,433	1	250	131	1	30	103,8 x 44,19

transmitting tubes

television service

COOLING: FA = forced air
N = natural
W = water
WH = water (helix)
V = vapour
H = heatsink

Triodes

type	status	output power sync kW	cooling	frequency at full ratings max. MHz	V_f V	I_f A	V_a kV	I_a sync black A	V_a max. kV	W_a max. sync kW	h x dia. max. mm
TBL6/6000 [1] TBW6/6000 [1]	C	**9**	FA W	75	12,6	33	5	3,8	5	5	195 x 122,6 190 x 70,5
TBL6/20	M	**17**	FA	88	6,3	154	6	4,8	5,5	10	277 x 169,5
TBL12/100 [1] TBW12/100 [1]	M	**100**	FA W	68	17,5	196	6,5	32	6,5	50	660 x 286 620 x 240

Tetrodes

type	status	output power sync kW	cooling	frequency at full ratings max. MHz	V_f V	I_f A	V_a kV	V_{g2} V	I_a sync black A	V_a max. kV	W_a max. sync kW	h x dia. max. mm
QEL1/150 QEL1/150H	C	**0,25**	FA	216	6 26,5	2,6 0,58	1,25	300	0,305	1,25	0,25	62,7 x 41,7
YL1590	D	**0,3**	FA	1000	3	40	3	550	0,25	3,6	1,5	62,7 x 41,7
QEL2/275 QEL2/275H	C	**0,44**	FA	216	6 26,5	2,6 0,58	2	350	0,355	2	0,25	62,7 x 41,7
QBL4/800	C	**0,6**	FA	220	5	13,5	2,4	500	0,4	3	0,5	120 x 67
YL1540 YL1440	D	**1,15** **1,55**	FA	260	4,2	53	3	700 500	0,7	4	2 1,5	122 x 63,3 125 x 63,3
QBL3.5/2000	M	**2,2**	FA	1000	3,6	58	4,32	600	0,9	4,5	1,5	215 x 89
YL1181 YL1182	C	**5,5**	FA V	230	5	64	4	600	1,5	4,2	4 6	178 x 100 178 x 122
YL1560	D	**6**	FA	1000	5	130	5	700	1,75	6	6	153 x 120,3
QBL5/3500 [1] QBW5/3500 [1]	C	**8**	FA W	110	6,3	32,5	5	800	2,7	5	3	169 x 97 160 x 70,5
YL1420 YL1580	D	**8,6** **12**	FA	260 1000	6,3 7	120 130	5 6	600 800	2,1 2,7	6,5 7,2	6 12	174 x 125,1
YL1430	D	**18,4**	FA	260	8	120	7	700	2,9	9	12	211 x 164,2
YL1520	D	**27,5**	FA	260	11,5	120	8	700	4	9	18	226 x 164,2

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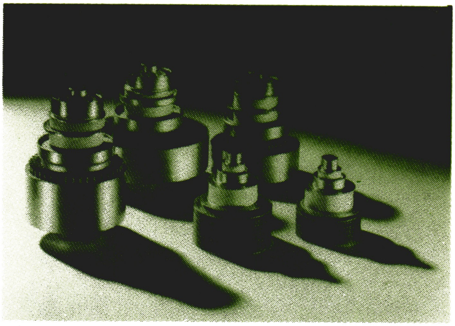
[1] Two tubes in push-pull.

television transposer service



Triodes for TV transposer service

COOLING: forced air

Triodes

type	status	output power sync W	power gain dB	frequency at full ratings max. MHz	V_f V	I_f A	V_a kV	I_a A	V_a max. kV	W_a max. kW	h x dia. max. mm
YD1270	D	**25**	19	1000	6,3	1,2	1,5	0,12	1,7	0,2	88,6 x 50,5
YD1303	D	**25**	20	1000	5	2	1,2	0,15	2	0,15	55,5 x 68,1
YD1300	D	**25**	20	1000	5	2	1,7	0,17	2	0,3	55,2 x 45,4
YD1302	D	**35**	20	1000	5	2	1,7	0,17	2	0,325	64,2 x 54,1
YD1304	D	**55**	19	1000	5	2,2	1,8	0,18	2	0,325	64,2 x 54,1
YD1333	C	**110**	16,5	1000	6,3	5,3	2	0,25	3,5	0,9	88,5 x 71
YD1334	D	**110**	16,5	1000	6,3	5,3	2,5	0,25	3,5	1,8	96,5 x 96
YD1330	C	**220**	16,5	1000	6,3	5,3	3	0,42	3,5	1,8	106 x 71
YD1336	D	**220**	16,5	1000	6,3	5,3	3	0,42	3,5	1,8	96,5 x 96
YD1335	D	**550**	15	1000	6,3	5,3	3,5	0,25	3,8	1,9	96,5 x 96

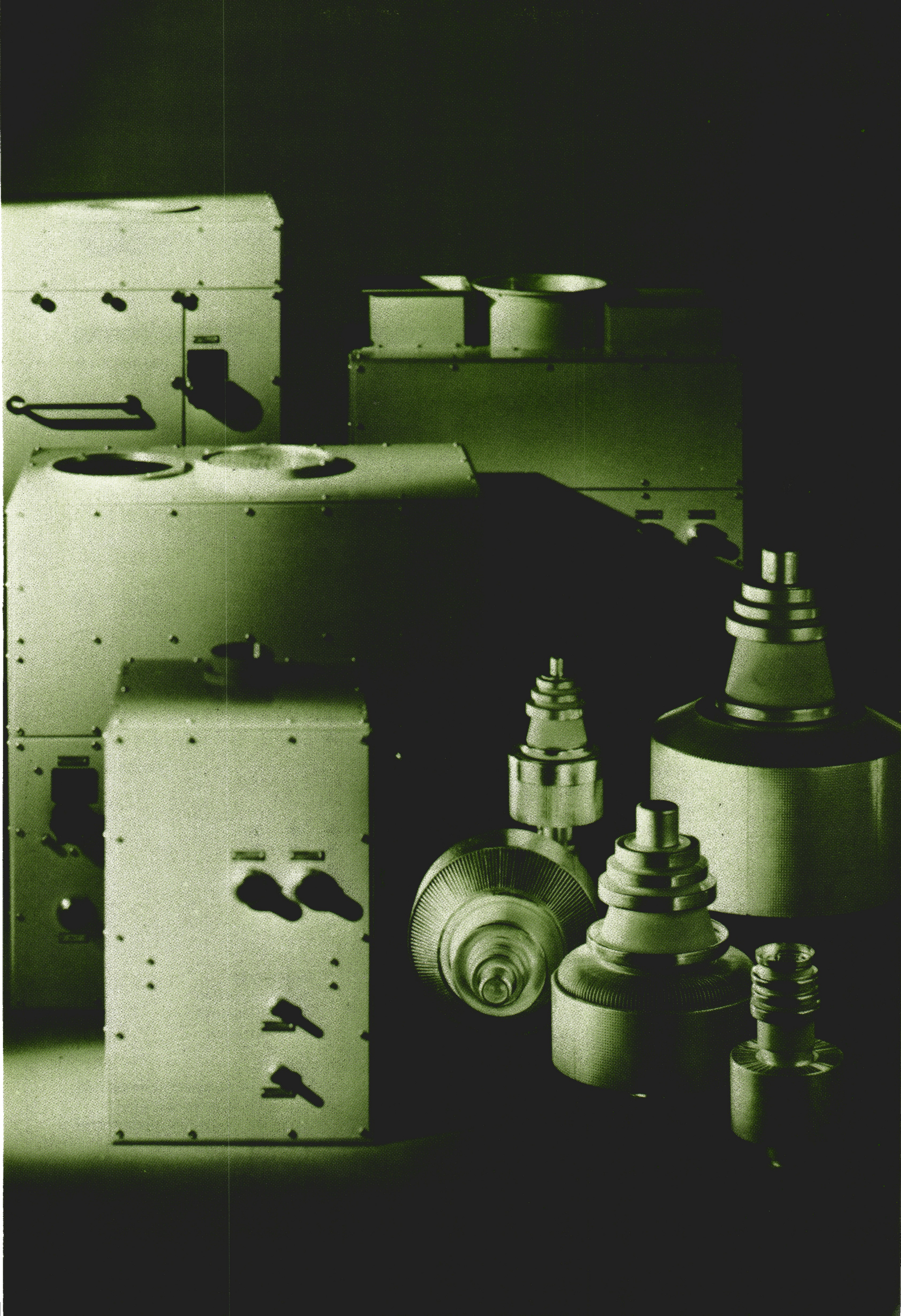
Tetrodes

type	status	output power sync kW	power gain dB	frequency at full ratings max. MHz	V_f V	I_f A	V_a kV	V_{g2} V	I_a A	V_a max. kV	W_a max. kW	h x dia. max. mm
YL1590	D	**0,22**	14	860	3,5	50	3	600	0,55	4,5	1,5	62,7 x 41,7
YL1440	D	**0,55**	15	260	4,2	53	2,5	600	0,73	4	1,5	125 x 63,3
YL1560	D	**2,2**	16	1000	5	130	5	800	1,5	6	6	153 x 120,3
YL1420	D	**2,5**	15	260	6,3	120	4	700	1	6,5	6	173 x 125,1
YL1430	D	**7**	15	260	8	120	6	800	1,2	9	12	211 x 164,2
YL1520	D	**10,5**	16	260	11,5	120	8	900	1,8	9	18	225 x 164,2

amplifier circuit assemblies

COOLING: forced air

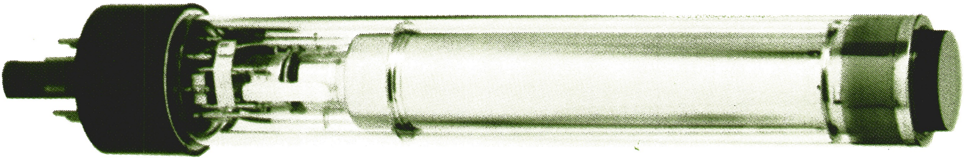
type	band	output power kW	carrier frequency range MHz	power gain x	tube used	dimensions in mm
Vision						
40771	IV + V	**0,5**	470 to 860	32	YD1335	627 x 239 x 182
40776	III	**1,15**	170 to 260	96	YL1540	600 x 345 x 320
40755	I	**1,2**	48 to 83	14	YL1440	516 x 323 x 323
40743	III	**1,55**	170 to 260	23	YL1440	673 x 333 x 323
40757	I	**6,25**	55,25 to 67,25 77,25 to 83,25	16 18,5	YL1420	700 x 500 x 500
40745	III	**8,6**	170 to 230	24	YL1420	600 x 620 x 370
40747	III	**18,4**	170 to 230	25	YL1430	600 x 620 x 370
40759	I I	**13,2** **20**	55,25 to 67,25 77,25 to 83,25	20 24	YL1430 YL1520	700 x 500 x 500
40768	III	**27,5**	170 to 230	28,5	YL1520	685 x 415 x 650
Sound						
40756	I	**2,4**	53 to 88	26	YL1440	516 x 323 x 323
40778	II	**2,4**	88 to 108	200	YL1540	330 x 300 x 300
40777	III	**2,4**	170 to 260	200	YL1540	600 x 345 x 320
40744	III	**2,4**	170 to 260	26	YL1440	673 x 333 x 323
40758	I	**10,5**	53 to 88	32	YL1420	700 x 500 x 500
40775	II	**10,5**	88 to 108	200	YL1470	400 x 360 x 555
40746	III	**10,5**	170 to 230	32	YL1420	600 x 620 x 370
40760	I I	**13** **25**	53 to 88	32,5 31	YL1430 YL1520	700 x 500 x 500
40748	III	**13**	170 to 230	33	YL1430	600 x 620 x 370
Vision and sound						
40770	IV + V	**35 W** **55 W**	470 to 860 470 to 860	100 63	YD1300 YD1302	482 x 246 x 88
40771	IV + V	**0,11** **0,22**	470 to 860 470 to 860	40 40	YD1334 YD1336	525 x 340 x 148
40743	III	**0,55**	175 to 225	30	YL1440	673 x 333 x 323
40745	III	**2,5**	175 to 225	30	YL1420	600 x 620 x 370
40747	III	**7**	175 to 225	32	YL1430	600 x 620 x 370
40768	III	**10,5**	175 to 225	42	YL1520	685 x 415 x 650



camera tubes

Plumbicon® tubes — 1¼ inch (30 mm)

○ magnetic focusing and deflection
○ separate mesh construction



For detailed information
Handbook ET5b

Current types **300 mA; 6,3 V**

type	max length mm	photo-conductive layer	quality grade Br	quality grade Ind	quality grade Med	applications B/W	applications L	applications R	applications G	applications B	applications Med	notes
XQ1020	215	S	●			●	●	●	●	●		
XQ1021	215	S		●		●		●	●	●		
XQ1022	210	S			●						●	1
XQ1023	215	ER	●			●	●	●				
XQ1024	215	ER		●		●		●				
XQ1025	215	ER(F)	●			●	●	●		●		2
XQ1026	215	ER(F)		●		●		●				2

Design types **300 mA; 6,3 V**

○ provision for both fixed and adjustable light bias
○ high resolution

type	max length mm	photo-conductive layer	quality grade Br	quality grade Ind	quality grade Med	applications B/W	applications L	applications R	applications G	applications B	applications Med	notes
XQ1410	215	SHR	●			●	●	●	●	●		
XQ1411	215	SHR		●		●		●	●	●		
XQ1413	215	ER	●			●	●	●				
XQ1414	215	ER		●		●		●				
XQ1415	215	ER(F)	●			●	●	●				2
XQ1416	215	ER(F)		●		●		●				2

New design types **190 mA; 6,3 V**
(63XQ; 63XQ-ER)

○ anti-comet-tail electron gun (ACT)
○ provision for both fixed and adjustable light bias
○ high resolution

type	max length mm	photo-conductive layer	quality grade Br	quality grade Ind	quality grade Med	applications B/W	applications L	applications R	applications G	applications B	applications Med	notes
XQ1520	215	SHR	●			●	●	●	●	●		
XQ1521	215	SHR		●		●		●	●	●		
XQ1523	215	ER	●			●	●	●				
XQ1524	215	ER		●		●		●				
XQ1525	215	ER(F)	●			●	●	●				2
XQ1526	215	ER(F)		●		●		●				2

Notes

1. Without anti-halation glass disc.
2. With infrared reflecting filter on anti-halation glass disc.
3. Without anti-halation glass disc: add suffix /01 to type number.
4. Add suffix /02 for rear loading type.

Abbreviations used in the tables

○ photoconductive layer

S	= standard
SHR	= special high resolution
ER	= with extended red response
ER(F)	= with extended red response and infrared reflecting filter on anti-halation glass disc

○ quality grade

Br	= broadcast
Ind	= industrial
Med	= medical

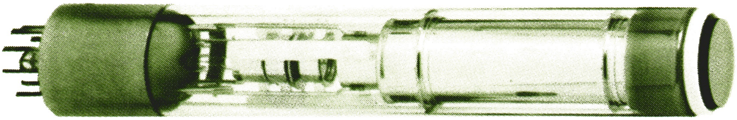
○ applications

B/W	= for black and white cameras
L	= for luminance channel
R	= for red chrominance channel
G	= for green chrominance channel
B	= for blue chrominance channel
Med	= medical; coupled to X-ray image intensifier

® *Plumbicon is a registered trade mark for tv camera tubes.*

Plumbicon® tubes — 1 inch (25,4 mm)

More than 80% of the world's colour tv cameras use Plumbicon® tubes



Current types

95 mA; 6,3 V

front loading type	max length mm	photo-conductive layer	quality grade Br	Ind	Med	applications B/W	L	R	G	B	Med	notes (previous page)
XQ1070	163	SHR	●			●	●	●	●	●		3 or 4
XQ1071	163	SHR		●		●		●	●	●		3 or 4
XQ1072	158	SHR			●						●	1
XQ1073	163	ER	●			●		●				3 or 4
XQ1074	163	ER		●		●		●				3 or 4
XQ1075	163	ER(F)	●			●		●				2, 4
XQ1076	163	ER(F)		●		●		●				2, 4

Current types

○ anti-comet-tail electron gun
○ provision for light bias

95 mA; 6,3 V

rear loading type	front loading type	max length mm	photo-conductive layer	quality grade Br	Ind	Med	applications B/W	L	R	G	B	notes (previous page)
XQ1080	**XQ1090**	163	SHR	●			●	●	●	●	●	
XQ1081	**XQ1091**	163	SHR		●		●		●	●	●	
XQ1083	**XQ1093**	163	ER	●			●		●			
XQ1084	**XQ1094**	163	ER		●		●		●			
XQ1085	**XQ1095**	163	ER(F)	●			●		●			2
XQ1086	**XQ1096**	163	ER(F)		●		●		●			2

New design types
(64XQ; 64XQ-ER)

○ high resolution anti-comet-tail electron gun
○ provision for light bias

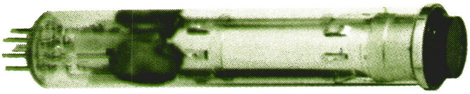
190 mA; 6,3 V

rear loading type	front loading type	max length mm	photo-conductive layer	quality grade Br	Ind	Med	applications B/W	L	R	G	B	notes (previous page)
XQ1500	**XQ1510**	163	SHR	●			●	●	●	●	●	
XQ1501	**XQ1511**	163	SHR		●		●		●	●	●	
XQ1503	**XQ1513**	163	ER	●			●		●			
XQ1504	**XQ1514**	163	ER		●		●		●			
XQ1505	**XQ1515**	163	ER(F)	●			●		●			2
XQ1506	**XQ1516**	163	ER(F)		●		●		●			2

camera tubes

Plumbicon® tubes — 2/3 inch (17 mm)

- ○ magnetic focusing and deflection
- ○ separate mesh construction



New design types **95 mA; 6,3 V**

type	max length mm	photo-conductive layer	quality grade Br	Ind	Med	applications B/W	L	R	G	B
XQ1427	112	ER SHR	●			●		●	●	●
XQ1428	112	ER SHR		●		●		●	●	●

Accessories for Plumbicon tubes

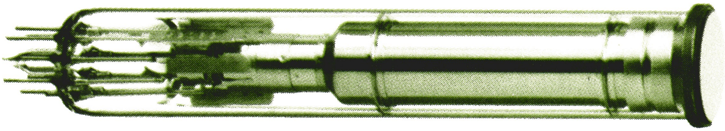
	1¼" dia. (all magnetic)		1" dia. (all magnetic)				2/3" dia. (all magnetic)
	standard (and light bias)	ACT + light bias	standard	02 versions	ACT + light bias	ACT + light bias	
	rear loading	rear loading	front loading	rear loading	rear loading	front loading	front loading
coil unit B/W	**AT1132/01**	**AT1132/01**	**AT1102/01** **AT1103** **AT1116**	**AT1119/01**	**AT1119/01**	**AT1116**	
coil unit colour	**AT1113/01**	**AT1113/01**	**AT1116/06**	**AT1115** *	**AT1115** *	**AT1116/06** *	**AT1105** **AT1106**
socket	**56021**	**56025**	**56098**	**56098**	**56026**	**56026**	**56049**
light bias lamp	**56106**	**56106**			**56027**	**56027**	
adapters **							
B/W	**56122**	**56122**					
R	**56123**	**56123**					
G	**56124**	**56124**					
B	**56125**	**56125**					
mask	**56029**	**56029**	**56028**	**56028**	**56028**	**56028**	**56033**

* Computer selected triplet.

** Adapters for fixed light bias for XQ1410 to 1416.

Vidicon and Newvicon® tubes

- ○ wide application range
- ○ choice of photoconductive layers
- ○ variety of sizes
- ○ silicon multi-diode array targets



All types 95 mA; 6,3 V

1 inch — magnetic focusing and deflection

type	status	max length mm	mesh	photo-conductive layer	quality grade Br	quality grade HI	quality grade Ind	applications Med	applications MS	applications GP
XQ1031	D	130	I	A		●	●		●	
XQ1032	D	130	I	A			●		●	●
XQ1240	D	159	S	A	●	●			●	
XQ1241	D	159	S	A			●		●	●
XQ1280	D	159	S	B				●		
XQ1285 *	D	159	S	B				●		
XQ1440	D	159	S	Nw		●	●		●	
XQ1442 *	D	160	S	Nw			●		●	

* Fibre-optic faceplate

2/3 inch — magnetic focusing and deflection

type	status	max length mm	mesh	photo-conductive layer	quality grade Br	quality grade HI	quality grade Ind	applications Med	applications MS	applications GP
XQ1270	D	105	I	A			●		●	●
XQ1271	D	105	S	A			●		●	●
XQ1274	D	108	S	Nw		●	●		●	
XQ1276 **	D	108	S	Nw			●		●	

** Extended red response

2/3 inch — electrostatic focusing and magnetic deflection

type	status	max length mm	mesh	photo-conductive layer	quality grade Br	quality grade HI	quality grade Ind	applications Med	applications MS	applications GP
XQ1272	D	105	S	A			●		●	●
XQ1275	D	108	S	Nw		●	●		●	

Vidicon tubes with silicon multi-diode array

(high sensitivity, wide spectral response, over-exposure resistant)

1 inch — magnetic focusing and deflection

type	status	max length mm	mesh	photo-conductive layer	quality grade Br	quality grade HI	quality grade Ind	applications Med	applications MS	applications GP
XQ1400	D	159	S	Si		●				
XQ1401	D	159	S	Si			●		●	
XQ1402	D	159	S	Si			●		●	●

Accessories for Vidicon and Newvicon tubes

type	deflection (and focusing) coil unit	socket
XQ1031, XQ1032, XQ1440, XQ1442 **XQ1240, XQ1241** **XQ1280, XQ1285** **XQ1400, XQ1401, XQ1402**	**AT1102/01, AT1103** **AT1116** or equivalent	**56098** or equivalent
XQ1270, XQ1271, XQ1274, XQ1276 **XQ1272, XQ1275**	**KV12S** or equivalent **KV19G** or equivalent	**56049** or equivalent

Abbreviations used in the tables

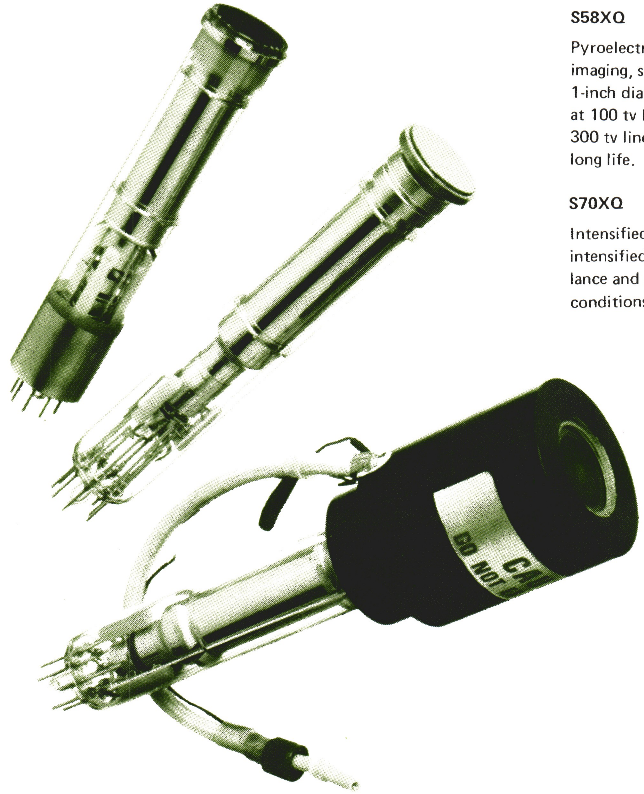
I = integral mesh
S = separate mesh
A = standard layer
B = layer with peak response at approx. 475 nm
Si = silicon multi-diode layer
Nw = cadmium and zinc telluride layer (Newvicon tubes)
Br = for black and white and colour broadcast cameras, telecine
HI = for high-quality black and white and colour cameras in sub-broadcast, medical, educational and industrial applications
Ind = for black and white and colour cameras in non-critical industrial applications
Med = in medical or industrial X-ray equipment, coupled with an image intensifier
MS = in cameras for military, surveillance, and scientific applications
GP = general purpose tube for low-cost cameras

® Newvicon is a registered trade mark for tv camera tubes.

special camera tubes

low light level tv
thermal imaging

Applications
scientific
military
surveillance
medical
industrial



30XQ

1-inch Plumbicon tube with anti-comet-tail (ACT) gun and provisions for light bias, with fibre-optic faceplate. High dynamic range and high speed of response make this tube, when coupled to an image intensifier with fibre-optic output window, a unique component for applications such as night traffic control, endoscopy, retinography, and material investigation.

S58XQ

Pyroelectric Vidicon (PEV) tube for thermal imaging, sensitive in the 8 to 14 μm region. This 1-inch diameter camera tube, resolving 0,15 °C at 100 tv lines and a limiting spatial resolution of 300 tv lines, is a hard-vacuum tube with a stable, long life.

S70XQ

Intensified silicon Vidicon (ISV) or silicon intensified target (SIT). Vidicon tube for surveillance and security systems, in very low light level conditions.

image intensifier tubes

A wide range of light intensifiers designed for use in military environments in direct view night-vision systems.

1st generation. Cascade image intensifiers.

These three-stage cascade image intensifiers are field proven devices. They are well established and are used in aiming and observation roles.

XX1060/01 This intensifier includes Automatic Brightness Control (ABC) and requires an external 2,7 kV power supply.

XX1063 Also incorporating ABC, this tube has an integral d.c. to a.c. converter and operates from 6,5 V batteries.

2nd generation. Microchannel plate image intensifiers.

All our second generation image intensifiers incorporate d.c. to a.c. converters giving automatic gain control characteristics. Particular features of the intensifiers are their low weight and point highlight saturation (Bright Source Protection). The devices are rugged and will withstand very severe environmental conditions.

XX1306 This small device is intended for application in lightweight aiming sights and small hand-held viewers.

XX1332 The only image intensifier of its kind in full-scale production designed to meet the requirements of driving applications.

XX1380 (18XX) This unique second generation device is intended to produce a high efficiency lightweight aiming sight.

XX1410 (F23XX) This double-proximity ('wafer') intensifier is a direct replacement for the intensifier used in the U.S. Army's AN/PVS5 goggle. The tube includes a fibre-optic inverter ('twister') output.

Characteristics of all types
- electrostatic self-focusing
- image inverting
- S25 high-sensitivity (250 μA/lm) photocathode
- P20 screen phosphor
- fibre-optic input and output

type	status	photocathode diameter mm	screen diameter mm	resolution lp/mm	gain	operating voltage	overall diameter mm	overall length mm	approx. mass g
XX1060/01	C	25	25	30	⩾ 50 000	2,7 kV(r.m.s.)	70	195	880
XX1063	D	25	25	30	⩾ 50 000	6,5 V(d.c.)	70	195	880
XX1306	D	18	18	27	⩾ 23 000 ⩽ 46 000	2,6 V(d.c.)	53	47	175
XX1332	D	50	40	22	⩾ 15 000 ⩽ 30 000	6,5 V(d.c.)	rectangular 92 x 66 x 101		800
XX1380 (18XX)	N	20	30	50	⩾ 3 000 ⩽ 25 000	2,6 V(d.c.)	62	80	350
XX1410 (F23XX)	N	18	18	28	⩾ 7 500 ⩽ 15 000	2,6 V(d.c.)	43	29	95

cathode-ray tubes

instrument tubes

Note particularly the flat-faced range:
- include rectangular tubes
- rugged construction
- compactness
- high current efficiency
- high control sensitivity

Mono-accelerator
Post-deflection accelerator

Types listed have GH (H) or G phosphors
Other phosphors on request.

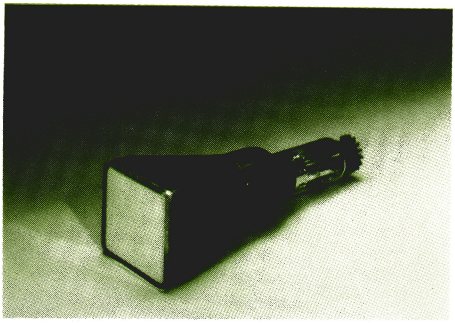
Heater: 6,3 V/300 mA } unless otherwise stated
Deflection: symmetrical x and y }

For detailed information
Handbook ET5a

Mono-accelerator tubes

type	status	min useful screen mm	min useful scan hor. mm	vert. mm	typ deflection coefficient hor. V/cm	vert. V/cm	typ accelerator voltage V	max overall length mm	notes
DH3-91	C	ϕ28	full	full	56,5	49	500	105	
DG7-5 **DG7-6**	M M	ϕ65	full	full	62,5	40	800	160	DG7-6 asymmetrical horizontal deflection
DG7-31 **DG7-32**	D D	ϕ65	full	full	37	21	500	172	DG7-31 asymmetrical horizontal deflection
Flat faced									
D7-190GH **D7-191GH**	D D	ϕ64	60	50	29	11,5	1000	225	D7-191GH heater 6,3 V/95 mA
D7-220GH **D7-221GH**	D D	60 x 36	60	36	13	21	1000	225	D7-221GH heater 6,3 V/95 mA
D10-160GH **D10-161GH**	D D	ϕ85	80	60	32	13,7	1500	260	D10-161GH heater 6,3 V/95 mA
D13-480GH **D13-481GH**	D D	ϕ114	100	80	31,3	14,4	2000	310	D13-481GH heater 6,3 V/95 mA
D14-250GH **D14-251GH**	D D	100 x 80	100	80	23	13,5	2000	333	D14-251GH heater 6,3 V/95 mA

All design types (status D) with post-deflection accelerator (p.d.a.) are now in a rectangular bulb and equipped with a mesh. Special attention is drawn to the D14-260GH and D14-290GH, new rectangular tubes with domed mesh, offering distinct performance advantages over helix p.d.a. tubes in a rectangular bulb – particularly with respect to overall length and uniformity of line width over the full screen area.



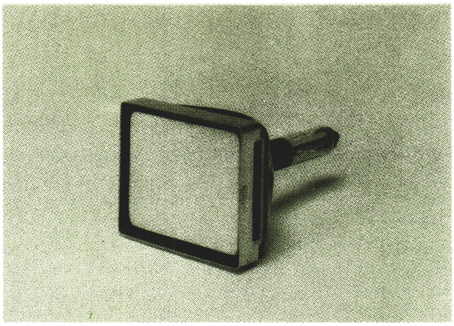
D14-260GH

Post-deflection accelerator tubes – flat faced

type	status	min useful screen mm	min useful scan hor. mm	min useful scan vert. mm	typ deflection coefficient hor. V/cm	typ deflection coefficient vert. V/cm	typ accelerator voltage first kV	typ accelerator voltage final kV	max overall length mm	post deflection accelerator	notes
Single beam											
DH7-11	C	ϕ68	60	45	10,7	3,65	1,2	1,2	296	helix	heater 6,3 V/95 mA
D10-170GH	C	ϕ85	80	60	13	3,5	1	6	335	mesh	
D13-27GH	C	ϕ114	full	80	24	11,5	1,5	3	354	helix	
D14-120GH	D	100 x 80	100	80	15,5	4,2	1,5	10	385	mesh	121 and 123 with side connections to x and y plates 122 and 123 with rotation coil
D14-121GH	D										
D14-122GH	D										
D14-123GH	D										
D14-162GH/09	D	100 x 80	100	80	15,2	4,1	1,5	10	407,5	mesh	with internal graticule and rotation coil
D14-260GH	D	100 x 80	100	80	20	10	– 2	4	333	mesh	
D14-290GH					12,8	6,3		10	343		
D18-120GH	C	120 x 100	120	100	15,5	4,5	2	10	454	mesh	
Double gun											
E10-12GH	M	ϕ85	full	70	15	7	1	3	410	helix	
E10-130GH	M	ϕ85	full	70	17	7,4	1	4	410	helix	
Split beam											
E14-100GH	D	100 x 80	100	80	13,5	9	1,5	10	425	mesh	E14-101GH without rotation coils
E14-101GH	D										
High-frequency tubes with internal graticule											
D14-240GH/37	D	100 x 80	100	80	9	3	2	20	385	mesh	with correction coil unit on request. Wide-band oscilloscopes 100-250 MHz
D13-500GH/01	M	100 x 60	100	60	13,5	1,7	2,5	15	492	mesh	with delay line system and correction coils. Wide-band oscilloscopes over 300 MHz.

cathode-ray tubes

monitor and data display
projection
flying spot scanner



M17-141W

Monitor and display tubes (see also recommended combinations, page C154)

W is the standard screen. Certain applications require screens of a different persistence and/or colour (e.g. GH, GR, GM). Tubes with such screens are supplied to special order.
Heater 6,3 V/300 mA; magnetic deflection; electrostatic focusing.

type	status	min useful screen hor. mm	vert. mm	deflection angle deg	neck diameter mm	typ accelerator voltage first V	final kV	max overall length mm	notes
M17-140W	D	124	93	70	28	400	14	234	
M17-141W	D	124	93	70	28	600	16	240	with bonded faceplate and metal mounting band
M24-100W	D	190	140	90	28	600	16	260	M24-101W, M31-131W, M38-121W with integral protection and mounting lugs
M24-101W	D								
M31-130W	D	257	195	90	28	600	16	310	
M31-131W	D								
M38-120W	D	290	226	110	28	400	16	279,5	
M38-121W	D								

Projection tubes

Heater 6,3 V/300 mA; magnetic deflection and focusing

type	status	min useful screen hor. mm	vert. mm	deflection angle deg	neck diameter mm	typ accelerator voltage first V	final kV	max overall length mm	notes
MG13-38	C	92	69	47	38	–	50	374	green phosphor
MU13-38									blue phosphor
MY13-38									red phosphor
MW13-38	C	92	69	47	38	–	50	374	white phosphor

Flying spot scanner tubes

Heater 6,3 V/300 mA; magnetic deflection

type	status	min useful screen mm	deflection angle deg	neck diameter mm	typ accelerator voltage first V	final kV	max overall length mm	focusing
Q7-100GU	D	ϕ60	36	28	600	16	211	electrostatic
Q13-110BA	C	ϕ108	40	38	–	25	347	magnetic
Q13-110GU								

storage tubes
screen phosphors and equivalents

Storage tubes – with variable persistence, internal graticule and correction coils, flat faced

type	status	min useful screen mm	min useful scan hor. mm	vert. mm	typ deflection coefficient hor. V/cm	vert. V/cm	typ accelerator voltage first kV	final kV	min writing speed * div/ms	min storage time ** minute	max overall length mm
L14-110GH/55	D	90 x 72	90	72	9,5	4,1	1,5	8,5	100	1,5	445
L14-130GH/55	D	90 x 72	90	72	9,5	8,5	1,5	8,5	100	1,5	445

Defined as the maximum speed at which a trace is just visible against a "just black" background. If some background is tolerated the writing speed can be raised to approx. 1 cm/µs.

** Defined as the time taken for the background to rise from zero luminance to 10% of saturated luminance. At reduced intensity the storage time can be longer.

Screen phosphors and equivalents

type designation Pro Electron	old	JEDEC	fluorescence colour	phosphorescence colour	persistence	typical use
BE	B	P11	blue	blue	medium short	oscillography and photography
GH	H	P31	green	green	medium short	general purpose oscillography
GJ	G	P1	yellowish-green	yellowish-green	medium	general purpose oscillography
GM	P	P7	purplish-blue	yellowish-green	long	low-speed oscillography
GP	–	P2	bluish-green	green	medium short	medium-speed oscillography, photography
GR	–	P39	green	green	long	monitoring and display devices
GU	–	–	white	white	very short	colour flying spot scanners
BA	C	–	purplish-blue	–	very short	black and white flying spot scanners
W	W	P4	white	–	medium short	television and monitoring devices
WA	–	–	white	–	medium short	studio monitors (white point matched to colour tv white point, D6500)

microwave products

tubes, semiconductors, sub-assemblies

Magnetrons
Klystrons
Travelling-wave tubes
Diodes and Triodes
Dual T-R switch
Semiconductor devices
Sub-assemblies

For detailed information
Handbook ET2a/b

Magnetrons

Communication magnetrons as pulsed oscillators for use in radar systems. Operating frequency 1,2 to 35 GHz. Available types have either fixed frequency or are tunable, including frequency agile types in 9 GHz and 16,5 GHz bands. Pulsed power outputs: 25 to 800 kW.

Magnetrons for microwave heating in domestic commercial, industrial and medical applications. These continuous-wave magnetrons operate in the 2,350 to 2,400 and 2,425 to 2,475 GHz bands. Magnetrons yielding power outputs from 200 W up to 6 kW can be supplied.

Klystrons

High power klystrons for operation in 10 to 55 kW u.h.f. television transmitters, or in transposers.
Frequency range: 470 to 860 MHz.

Pulse klystrons have been designed for linear accelerators with an operating frequency of 2998 ± 5 MHz.
Pulsed output power: 6 and 25 MW.

Low power klystrons for local oscillator applications.
These types are frequency tunable and their ranges are:
10,5 to 12,2 GHz
67 to 74 GHz
Power outputs: 130 to 400 mW.

Travelling-wave tubes

TWT for wide-band microwave link applications.
Operating frequencies: 3,4 to 8,5 GHz.
Saturated output powers: 15 to 25 W.

Diodes

Measuring diodes, frequency 1000 MHz.
Maximum peak inverse voltage 1000 V

High-vacuum, high-voltage diode for rectifying and surge limiting purposes.

Triodes

Disc seal triodes for use as power amplifiers, oscillators or frequency multipliers, etc.
Operating frequencies: 1 to 4,2 GHz.

Pencil type triodes for r.f. and i.f. amplifiers, mixers, oscillators and frequency multipliers, etc.
Ruggedized versions of some types are available.

Dual T-R switch

A broad-band, gas-filled, dual T-R switch covering the 8490 to 9580 MHz frequency band.
Peak power max 250 kW.

Semiconductor devices

Gunn effect diodes (GaAs).
Impatt diodes for generation of c.w. power up to 14 GHz.
Mixer diodes, low noise – for X, J and Q-bands.
Detector diodes (Schottky barrier), high sensitivity, low noise.
Backward diodes, broadband low level detection.
Multiplier varactor diodes, silicon planar epitaxial diodes for frequency multiplier circuits.
Tuning varactor diodes for tuning circuits.
Special purpose microwave devices.

Sub-assemblies

Gunn effect oscillators.
Fast tuning oscillators.
Voltage controlled oscillators.
YIG tuned oscillators.
Solid state klystrons.
Stable oscillators for link equipment.
Schottky barrier detectors.
Mixers.
Amplifiers.
Doppler sensors for anti-intrusion systems.
Traffic radar sensors.
Microwave barriers for peripheral anti-intrusion systems.
Special microwave solid state functions to customer specification.

circulators and isolators

coaxial circulators

For detailed information
Handbook ET2b

Types shown in tables are standard types.
Special types can be made to specification.

Coaxial circulator series, bands IV-V, 100 W, U.H.F., TV

frequency range	isolation		insertion loss		v.s.w.r.		max power		temperature range	connector type	mass approx	catalogue no.
	min	typ	max	typ	max	typ	c.w.	peak sync				
MHz	dB	dB	dB	dB			W	W	°C		g	
400–470	20	25	0,5	0,35	1,25	1,15	100	200	–10 to 60	N-female	400	2722 162 03411
470–600	20	25	0,5	0,35	1,25	1,15	100	200	–10 to 60	N-female	400	01551
600–800	20	25	0,5	0,35	1,25	1,15	100	200	–10 to 60	N-female	400	01561
790–1000	20	25	0,5	0,3	1,25	1,14	100	200	–10 to 60	N-female	400	03261

Coaxial circulator series, 300 W, U.H.F., TV

frequency range	isolation min	isolation typ	insertion loss max	insertion loss typ	v.s.w.r. max	v.s.w.r. typ	max power c.w.	max power peak sync	temperature range	connector type	mass approx	catalogue no.
400–470	20	25	0,35	0,20	1,25	1,15	300	500	–10 to 60	N-female	1200	2722 162 01572
400–470	20	25	0,35	0,20	1,25	1,15	300	500	–10 to 60	HF 7/16	1200	01622
470–600	20	25	0,35	0,20	1,25	1,15	300	500	–10 to 60	N-female	1200	01582
470–600	20	25	0,35	0,20	1,25	1,15	300	500	–10 to 60	HF 7/16	1200	01632
590–720	20	25	0,35	0,20	1,25	1,15	300	500	–10 to 60	N-female	1200	01592
590–720	20	25	0,35	0,20	1,25	1,15	300	500	–10 to 60	HF 7/16	1200	01642
710–860	20	25	0,35	0,20	1,25	1,15	300	500	–10 to 60	N-female	1200	01612
710–860	20	25	0,35	0,20	1,25	1,15	300	500	–10 to 60	HF 7/16	1200	01662

Coaxial circulator series, 500 W/1 kW, V.H.F., TV

frequency range	isolation min	isolation typ	insertion loss max	insertion loss typ	v.s.w.r. max	v.s.w.r. typ	max power c.w.	max power peak sync	temperature range	connector type	mass approx	catalogue no.
160–178	20	24	0,35	0,3	1,25	1,15	500	850	–10 to 60	N-female	2100	2722 162 01871
160–178	20	24	0,35	0,3	1,25	1,15	1000	1800	–10 to 40*	HF 7/16	2150	01901
173–204	20	24	0,35	0,3	1,25	1,15	500	850	–10 to 60	N-female	2100	01861
173–204	20	24	0,35	0,3	1,25	1,15	1000	1800	–10 to 40*	HF 7/16	2150	01891
200–230	20	24	0,35	0,3	1,25	1,15	500	850	–10 to 60	N-female	2100	01851
200–230	20	24	0,35	0,3	1,25	1,15	1000	1800	–10 to 40*	HF 7/16	2150	01881
225–270	20	24	0,35	0,3	1,25	1,15	500	850	–10 to 60	N-female	2100	03171
225–270	20	24	0,35	0,3	1,25	1,15	1000	1800	–10 to 40*	HF 7/16	2150	03181

Coaxial circulator series, bands IV-V, 500 W/2 kW, U.H.F., TV

frequency range	isolation min	isolation typ	insertion loss max	insertion loss typ	v.s.w.r. max	v.s.w.r. typ	max power c.w.	max power peak sync	temperature range	connector type	mass approx	catalogue no.
470–600	22	24	0,35	0,25	1,2	1,15	500	900	–10 to 70	N-female**	2080	2722 162 01121
470–600	20	24	0,35	0,17	1,25	1,12	2000	2000	–10 to 40*	HF 7/16	2000	01261
590–720	22	24	0,35	0,25	1,2	1,15	500	900	–10 to 70	N-female**	2080	01131
590–720	22	27	0,35	0,15	1,2	1,1	2000	2000	–10 to 40*	HF 7/16	2000	01281
600–800	20	24	0,35	0,17	1,25	1,13	2000	2000	–10 to 40*	HF 7/16	2000	01331
710–860	22	24	0,35	0,25	1,2	1,15	500	900	–10 to 70	N-female**	2080	01141
710–860	22	26	0,35	0,16	1,2	1,15	2000	2000	–10 to 40*	HF 7/16	2000	01271

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* With air cooling (filtered) at a pressure of 25 mm water column and maximum 40 °C intake temperature, the permissible connector temperature is +60 °C.

** Also available with connector HF 7/16 (to DIN 47223), EIA 7/8, and EIA 1 5/8.

microwave products

circulators and isolators

coaxial circulators/isolators

Coaxial circulator/isolator series, octave bandwidth

frequency range GHz	isolation min dB	isolation typ dB	insertion loss max dB	insertion loss typ dB	v.s.w.r. max	v.s.w.r. typ	max power forward W	max power reverse W	temperature range °C	connector type	mass approx g	catalogue no.
2–4	20	24	0,5	0,35	1,25	1,15	50	–	–10 to 70	N-female	300	2722 162 01491
2–4	20	24	0,5	0,35	1,25	1,15	50	–	–10 to 70	SMA	300	01501
2–4	20	24	0,5	0,35	1,25	1,1	50	5	–10 to 70	N-female	300	02091
2–4	20	24	0,5	0,35	1,25	1,1	50	5	–10 to 70	SMA	300	02101
3–6	20	27	0,5	0,3	1,25	1,1	20	–	–10 to 70	SMA	120	01511
3–6	20	27	0,5	0,3	1,25	1,1	20	5	–10 to 70	SMA	120	02071
4–8	20	23	0,5	0,3	1,25	1,15	10	–	–10 to 70	SMA	100	01811
4–8	20	27	0,5	0,3	1,25	1,15	10	10	–10 to 70	SMA	100	02111
7–12,7	20	23	0,6	0,4	1,25	1,15	10	–	–10 to 70	SMA	60	01821
7–12,7	20	25	0,6	0,35	1,25	1,12	10	–	–10 to 70	SMA	100	02121
12–18	18	22	0,6	0,35	1,30	1,2	5	–	–10 to 70	SMA	20	03301
12–18	18	22	0,6	0,35	1,25	1,2	5	1	–10 to 70	SMA	20	02221

Coaxial circulator/isolator series (3-port versions), standard bands

frequency range GHz	isolation min dB	isolation typ dB	insertion loss max dB	insertion loss typ dB	v.s.w.r. max	v.s.w.r. typ	max power forward W	max power reverse W	temperature range °C	connector type	mass approx g	catalogue no.
0,225–0,27	18	21	0,35	0,2	1,35	1,25	150	–	0 to 70	N-female	725	2722 162 01931
0,27 –0,33	18	21	0,35	0,2	1,35	1,25	150	–	0 to 70	N-female	725	01941
0,33 –0,40	18	21	0,35	0,3	1,35	1,25	150	–	0 to 70	N-female	725	01951
0,79 –1	20	25	0,5	0,3	1,25	1,14	100	–	–10 to 60	N-female	400	03261
0,96 –1,225	20	22	0,5	0,35	1,25	1,20	100	–	–10 to 60	N-female	460	03591
1,48 –1,95	20	28	0,3	0,3	1,2	1,08	50	2	0 to 70	N-female	500	02041
3,8 –4,2	25	27	0,25	0,2	1,12	1,10	10	–	–10 to 70	SMA	110	03431
4,4 –5	25	27	0,25	0,2	1,12	1,10	10	–	–10 to 70	SMA	110	03441
7,9 –10,4	20	22	0,4	0,35	1,25	1,23	5	1	–10 to 70	SMA	30	02231

Coaxial circulator series (4-port versions), standard bands

frequency range GHz	isolation (dB) max α1-4 α3-2	isolation (dB) max α2-1 α4-2	isolation (dB) typical α1-4 α3-2	isolation (dB) typical α2-1 α4-3	insertion loss (dB) max α4-1 α2-3	insertion loss (dB) max α1-2 α3-4	insertion loss (dB) typical α4-1 α2-3	insertion loss (dB) typical α1-2 α3-4	v.s.w.r. max	v.s.w.r. typ	max power (c.w.) W	temperature range °C	connector type	catalogue no.
3,8–4,2	25	50	27	52	0,25	0,5	0,2	0,4	1,12	1,1	10	–10 to 70	SMA	2722 162 04031
4,4–5	25	50	27	52	0,25	0,5	0,2	0,4	1,12	1,1	10	–10 to 70	SMA	04041

waveguide circulators
industrial heating isolators

Waveguide circulator series (3-port versions)

frequency range GHz	isolation min dB	isolation typ dB	insertion loss max dB	insertion loss typ dB	v.s.w.r. max	v.s.w.r. typ	max power W	temperature range °C	flange type (IEC)	mass approx g	**catalogue no.**
3,4 –3,8	28	35	0,4	0,15	1,08	1,04	50	0 to 50	UER40	1500	2722 161 02261
3,8 –4,2	28	35	0,2	0,15	1,08	1,04	50	0 to 50	UER40	1500	02231
5,925–6,425	30	35	0,2	0,15	1,06	1,04	100	–10 to 70	UER70	950	02101
6,425–7,125	30	33	0,15	0,13	1,07	1,04	100	–10 to 70	UER70	950	02081
7,125–7,750	30	33	0,2	0,13	1,06	1,04	100	–10 to 70	UER70	950	02091
7,7 –8,5	25	32	0,5	0,2	1,1	1,05	50	10 to 40	UER84	825	02191
7,7 –8,5	25	28	0,5	0,3	1,1	1,08	50	10 to 40	UER84	825	02281
7,9 –8,4	30	33	0,3	0,15	1,06	1,04	50	10 to 40	UER84	825	02271

Waveguide circulator series (4-port versions)

frequency range GHz	isolation min $\alpha_{1\text{-}3}$ dB	isolation min $\alpha_{1\text{-}4}$ dB	insertion loss max dB	insertion loss typ dB	v.s.w.r. max $\alpha_{1\text{-}3}$	v.s.w.r. typ $\alpha_{1\text{-}4}$	nominal power (c.w) W	temperature range °C	flange type (IEC)	mass approx g	catalogue no.
5,925–6,175	33	20	0,1	0,10	1,05	1,04	150	10 to 60	UER70	920	2722 161 03081
6,125–6,425	30	20	0,1	1,10	1,06	1,06	150	10 to 60	UER70	920	03091
6,575–6,875	25	20	0,4	0,35	1,10	1,10	100	10 to 60	UER70	920	03031
6,825–7,125	25	18	0,4	0,35	1,08	1,08	100	10 to 60	UER70	920	03011
7,125–7,425	25	18	0,3	0,25	1,10	1,10	100	10 to 60	UER70	920	03001
7,425–7,725	30	20	0,4	0,35	1,10	1,10	100	10 to 60	UER70	920	03041
10,7 –11,7	30	18	0,3	0,25	1,10	1,10	25	10 to 60	UER100	390	03061
12,5 –13,5	25	20	0,3	0,25	1,10	1,10	25	10 to 60	UER140/ UBR140	320	03051

Industrial heating isolators

frequency range GHz	isolation min dB	isolation typ dB	insertion loss max dB	insertion loss typ dB	v.s.w.r. max dB	v.s.w.r. typ dB	max c.w. power forward/ reverse W	cooling water temp. (water pressure 600 kPa abs) inlet °C	outlet °C	flange type (IEC)	mass approx g	catalogue no.
2,425–2,475	20	26	0,3	0,2	1,2	1,1	6500	40	50	PDR26	4700	2722 163 02004
2,350–2,400	20	26	0,3	0,2	1,2	1,1	6500	40	50	PDR26	4700	02024

microwave products

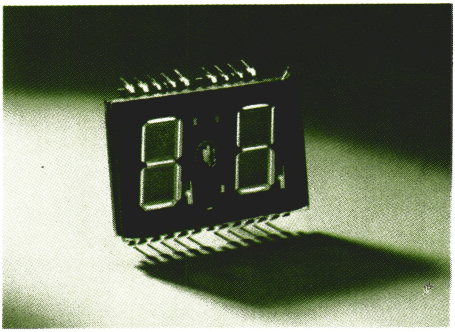
circulators and isolators

waveguide isolators

Waveguide isolator series

frequency range GHz	isolation min dB	insertion loss, max dB	v.s.w.r. max	power (c.w.) W	temperature range °C	waveguide type (IEC)	flange type (IEC)	mass approx g	catalogue no.
3,8 –4,2	30	0,8	1,05	10	10 to 40	R48	UER48	1700	2722 161 01071
3,8 –4,2	30	0,5	1,05	10	10 to 80	R40	UER40	2450	01081
4,2 –4,6	30	0,5	1,05	10	10 to 40	R48	UER48	1680	01091
4,6 –5,0	30	0,8	1,05	10	10 to 40	R48	UER48	1680	01101
5,925–6,425	30	0,3	1,05	20	–10 to 70	R70	UER70	1450	01191
6,425–7,150	30	0,3	1,05	20	–10 to 70	R70	UER70	1450	01251
6,825–7,425	30	0,3	1,05	20	–10 to 70	R70	UER70	1450	01231
7,125–7,750	30	0,3	1,05	20	–10 to 70	R70	UER70	1450	01291
7,250–7,750	30	0,3	1,05	20	–10 to 70	R70	UER70	1450	01241
7,4 –8,025	30	0,5	1,05	10	–10 to 70	R70	UER70	1450	01151
7,7 –8,5	30	0,5	1,05	10	10 to 70	R84	UBR84	1260	01161
8,5 –9,6	30	0,5	1,05	10	–10 to 70	R100	UBR100	420	01211
8,5 –9,6	15	0,6	1,15	1	10 to 70	R100	UBR100	400	01221
8,5 –9,6	55	1,2	1,2	10	–10 to 70	R100	154-UER100	600	01261
8,5 –9,6	20	1	1,15	10	–10 to 70	R100	154-UBR100	300	01271
10,7 –11,7	30	0,8	1,05	5	10 to 70	R100	UBR100	430	01171
12,5 –13,5	30	0,5	1,05	10	10 to 70	R140	UBR100	220	01181

gas-filled tubes



Segment indicator tubes
Indicator tubes
Switching diodes
Dry reed switches

For detailed information
Handbook ET7a and 7b

Segment indicator tubes

Cold cathode, long life, indicator tube in a flat envelope. Two or more tubes may be stacked horizontally. Suitable for direct drive with 30 V ICs.

type	characters	character height mm	execution (digits)	decade pitch mm
ZM1550	formed by 7 segments	15	2	17,78
ZM1551	+ — 1 and 7 segments	15	1½	17,78

Indicator tubes

Cold cathode, long life, indicator tubes;
side-viewing or top-viewing types are available

type	characters	character height mm	execution
ZM1040	0 to 9	30	side viewing, red coating
ZM1041	+ —	20	" , "
ZM1042	0 to 9	30	"
ZM1043	+ —	20	"

Switching diodes

Cold cathode, neon filled, subminiature switching and light diodes, intended for low-speed switching.

ZA1002, ZA1004, ZA1006

Dry reed switches

Single pole, single throw, dry reed switches having normally open contacts.
The devices are intended for general industrial applications such as push buttons and relays.

series	RI-20	RI-21	RI-42	RI-43 for telephone
maximum glass length (mm)	15	15,24	21	21
maximum glass diameter (mm)	2,8	2,54	4	4
maximum switched power (W)	10	10	10	10
maximum switched voltage (V)	150	150	350 *	200
maximum switched current (mA)	500	500	500	500

Life expectancy minimum 10^8 operations with a failure rate $< 10^{-8}$.
RI-20 and RI-21 are available in 3 groups of AT selections.

* RI-42 is a switch with a high breakdown voltage of at least 1000 V.

Thyratrons
Ignitrons
High-voltage rectifying tubes
Accessories

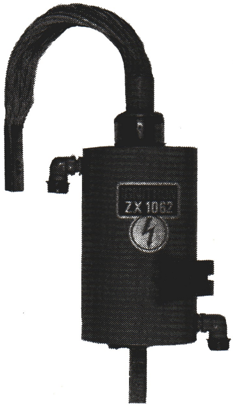
Thyratrons

Mercury vapour and inert gas-filled triode and tetrode thyratrons. Applications in relay service, motor control, igniter firing, etc.
Average currents ranging from 100 mA to 25 A.

Ignitrons

B, C and D-size ignitrons used in single and three-phase resistance welding control equipment and in similar a.c. control applications.
Maximum demand power varies from 600 kVA for a B-size to 3225 kVA for a D-size ignitron.

igniter current: max. 12 A
igniter voltages: 150 to 180 V



High-voltage rectifying tubes

A series of rectifying tubes either xenon-gas filled or mercury-vapour filled.
Mainly for use in transmitters, etc.
Peak inverse voltages from 2 to 27 kV.
Output currents range from 250 mA to 10 A.

Associated accessories

Include: cooling water connections for ignitrons
bimetal time delay relays for thyratrons and high-voltage rectifiers
water saving thermostats
protecting thermostats

products for nuclear technology

Geiger-Mueller tubes

For detailed information
HandbookET6/ET9

cylinder types

	status	application	γ counting rate count/s	at R/h	sensitive length mm	plateau threshold voltage V	plateau length V	max plateau slope %/V	max dead time µs	max background (shielded) count/min
ZP1200	C	γ	220	10^{-2}	40	400	200	0,04	90	10
ZP1210	D	γ	1000	10^{-2}	140	400	100	0,15	200	50
ZP1220	D	γ	1600	10^{-2}	240	400	100	0,1	200	90
ZP1300	D	β, γ	350	1	8	500	100	0,3	11	1
ZP1310	D	β, γ	1400	1	16	500	150	0,15	15	2
ZP1311 *	D	β, γ	1400	1	16	500	150	0,15	15	2
ZP1320	D	β, γ	7400	1	28	500	150	0,08	45	12
ZP1330	D	β, γ	900	10^{-2}	75	450	350	0,2	70	30

* With Sn filter

glass types

ZP1500	D	β, γ	700	10^{-2}	70	450	150	0,15	60	50
ZP1501	C	β, γ	700	10^{-2}	70	450	150	0,15	60	50
ZP1520	D	β, γ	—	—	60	400	100	0,15	100	50

window types

					window ϕ(mm)	th **					
ZP1400	D	β, γ	220	10^{-2}	9	(3)	400	200	0,04	90	10
ZP1410	D	α, β, γ	320	10^{-2}	19,8	(1)	450	250	0,02	175	15
ZP1430	D	α, β, γ	450	10^{-2}	27,8	(1)	450	250	0,035	190	25
ZP1442	D	β, (γ)	160	10^{-2}	19,8	(3)	500	200	0,09	65	8
ZP1441	M	α, β, (γ)	160	10^{-2}	19,8	(1)	500	200	0,09	65	5
ZP1452	D	β, (γ)	320	10^{-2}	27,8	(3)	500	250	0,07	60	18
ZP1451	M	α, β, (γ)	320	10^{-2}	27,8	(1)	500	250	0,07	60	9
ZP1460	D	β, (γ)	900	10^{-2}	51	(5)	700	400	0,04	45	45

special type

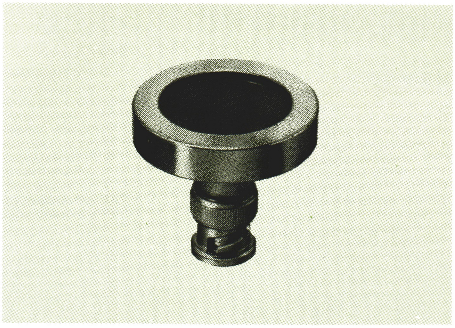
ZP1700	M	cosmic-ray guard tube	1300	10^{-2}	—	—	800	400	0,03	1000	70

X-ray types

ZP1600	D	2,5 to 100 keV	600	10^{-2}	ϕ 19,8	(4)	1600	400	0,06	110	25
ZP1610	D	2,5 to 40 keV	—		7 x 18	(2)	1900	working voltage 1460 to 1850 V			

** Window thickness in mg/cm^2 (1) = 1,5 to 2,0 (2) = 2,0 to 2,5 (3) = 2,0 to 3,0 (4) = 2,5 to 3,5 (5) = 3,5 to 4,0

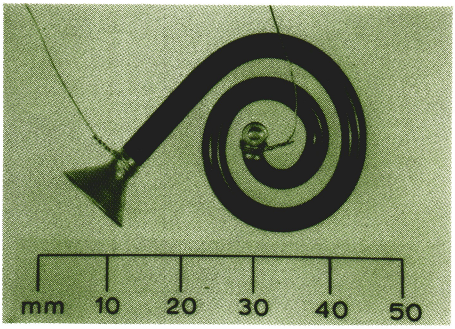
Fission chambers
Electron multipliers
Radiation detectors and cryostats



Silicon surface barrier particle detector.

Fission chambers

Detectors for in-core neutron fluxmonitoring in nuclear power reactors



Single channel electron multiplier

Channel electron multipliers

- glass planar spiral tubes
- glass C-shaped tubes

typical gains approx. 10^8

Channel electron multiplier plates

- an array of channel multipliers fused into the shape of a disc

typical gain approx. 10^3

Lithium drifted germanium detectors

For gamma and high energy X-ray spectrometry
Energy ranges from 10 keV to 10 MeV
These detectors must be operated at liquid nitrogen temperatures.

coaxial types
- double open-ended
- single open-ended
- well type

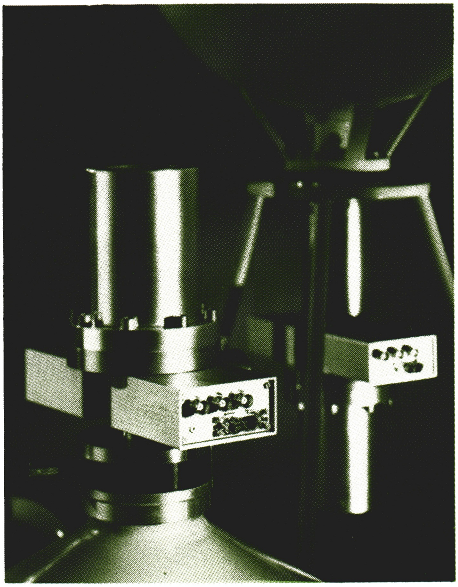
planar type
- with depletion depths from 5 to 12 mm

Silicon surface barrier detectors

Uses include spectrometry of alpha and low energy beta radiation, particles and fission products.
Both partially and totally depleted types are available, either circular or annular. Custom-made detectors can also be supplied.

Cryostats

A series of cryostats is available in various sizes. All cryostats have metal seals at the hood and pump stem and are zeolite pumped. They have a life expectancy of 5 years.

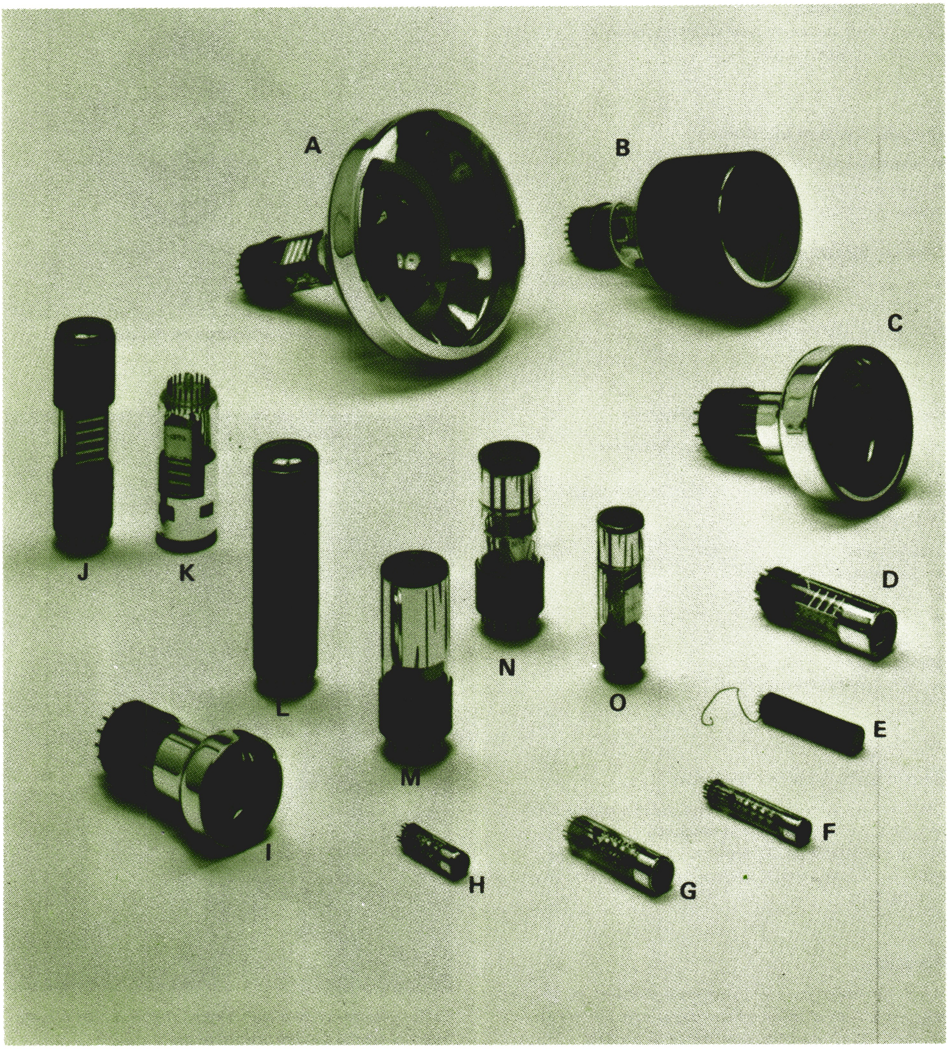


Ge(Li) detector system with preamplifier and high voltage filter, as used in gamma spectrometry.

photomultipliers

survey

professional tubes for professional use


A
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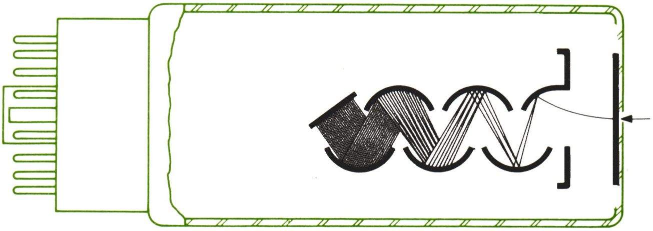
C264



photocathode spectral sensitivity characteristic	useful dia. mm	type	status	number of stages	photocathode spectral sensitivity, N_{kr} mA/W at	λ(nm)	anode luminous sensitivity or gain A/lm	at total voltage V	rise time ns	picture (see opposite)
S11 (A)	14	PM1910	D	10	60	437	60*	1400	2,5	F
	14	PM1920	N	6	60	437	0,2*	700	2	H
	23	PM1980	D	10	70	437	60*	1400	2,5	G
	44	56AVP	M	14	60	437	3 x 10^7	1800	2,1	J
SUPER A	32	PM2060B	D	10	70	437	60	1180	2,5	D
	32	XP2008	D	10	70	437	60	1180	2,5	D
	32	XP2010	C	10	80	437	60	1180	2,5	D
	32	XP1011	M	10	80	437	60	1500	3,5	–
S11 (UV extended)	110	XP2040	C	14	70	437	3 x 10^7	2000	2	B
S13 (U)	14	PM1918	N	10	60	437	60*	1400	2,7	E
	32	PM2018B	N	10	75	437	60*	1350	2,5	D
D	23	PM1982	N	11	80	401	250*	1450	2,5	G
	32	PM2012B	D	10	77	401	60*	1350	2,5	D
	44	PM2232	D	12	80	401	3 x 10^7	1900	2,2	K
	44	PM2202B	D	10	75	401	60*	1400	3,5	N
	44	56DVP	M	14	80	401	3 x 10^7	1900	2,1	L
	44	XP2020	D	12	85	401	3 x 10^7	2200	1,5	L
	44	XP2230	D	12	90	401	3 x 10^7	2300	1,6	K
	44	XP2000	D	10VB	85	401	12*	1250	10	M
	61	PM2402	N	10VB	90	401	12*	1250	10	–
	68	PM2312	N	12	85	401	3 x 10^7	2000	2,5	–
	70	XP2030	D	10VB	105	401	12*	1250	11	I
	110	XP2050	D	10VB	95	401	12*	1270	16	C
	200	60DVP	C	12	70	401	3 x 10^7	3000	2,1	A
D (UV extended)	110	XP2041	D	14	85	401	3 x 10^7	2200	2	B
DU	44	XP2020Q	C	12	80	401	3 x 10^7	2200	1,5	L
S20 (T)	14	XP1117	C	9	13	698	30	1520	3,5	E
	32	PM2013B	D	10	20	698	60	1250	2,5	O
	44	56TVP	M	14	15	698	3 x 10^7	2050	2,1	L
	44	XP1002	D	10	16	698	60	1460	4	N
TU	44	56TUVP	M	14	15	698	3 x 10^7	2050	2,1	L
S20R	32	XP1017	D	10	6,5	858	60	1470	3,5	O
S1 (C)	14	XP1116	M	10	1,6	903	10	1650	3,5	E
	32	150CVP	C	10	1,4	903	10	1600	3,5	D
	44	56CVP	M	10	1,4	903	10	1800	2,1	J

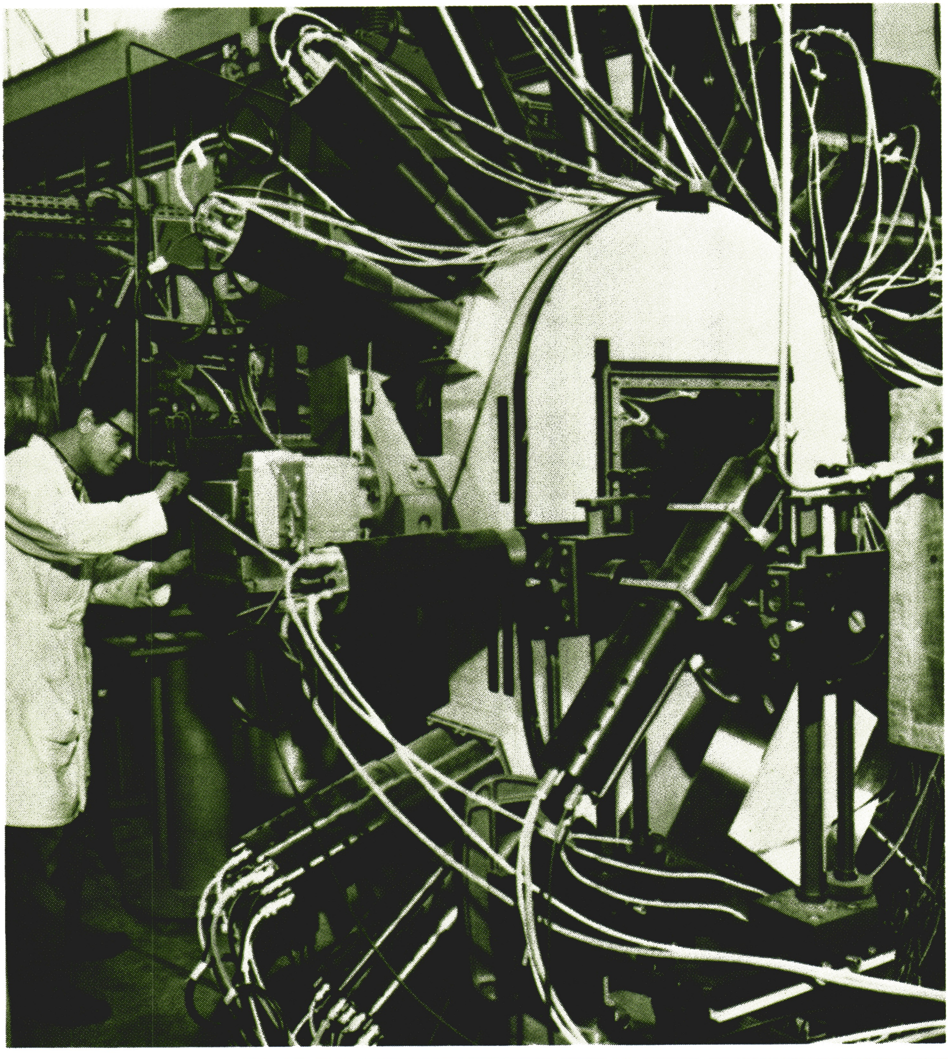
VB = Venetian blind.

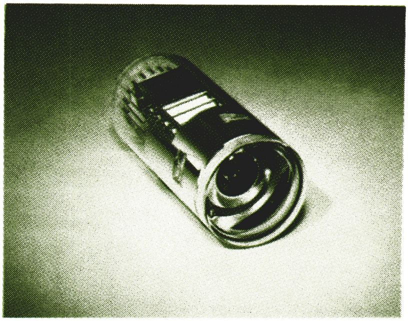
* anode spectral sensitivity (kA/W)

photomultipliers
for physics

Cerenkov detection
Fast coincidence techniques
Hodoscopy
Photon counting
Scintillation counting
Time spectroscopy

The HERA experiment: a hodoscope with 24 detectors using the 56DVP for detection of 6 GeV π^- - mesons (Courtesy of Centre d'Etudes Nucléaires de Saclay, C.E.A., France).





XP2230

Fast tubes

useful dia. (mm)	type	status	spectral sensitivity characteristic	number of stages	anode pulse rise time (ns)	transit time fluctuation (ns)
44	**PM2232**	D	D	12	2,2	–
44	**56AVP**	M	S11(A)	14	2,1	0,50
44	**56DVP**	M	D	14	2,1	0,50
44	**XP2020**	D	D	12	1,5	0,25
44	**XP2230**	D	D	12	1,6	0,35
44	**XP2020Q**	C	DU	12	1,5	0,25
44	**56TVP**	M	S20(T)	14	2,1	0,50
44	**56TUVP**	M	TU	14	2,1	0,50
44	**56CVP**	M	S1(C)	10	2,1	0,50
68	**PM2312**	N	D	12	2,5	–
110	**XP2040**	C	S11 extended UV	14	2,0	–
110	**XP2041**	D	D extended UV	14	2,0	–
200	**60DVP**	C	D	12	2,1	–

General purpose

useful dia. (mm)	type	status	spectral sensitivity characteristic	number of stages	anode pulse amplitude resolution ^{137}Cs (%)
14	**PM1910**	D	S11(A)	10	7,6
23	**PM1980**	D	S11(A)	10	7,6
32	**XP2008**	D	SUPER A	10	8
32	**PM2012B**	D	D	10	7,2
32	**XP2010**	C	SUPER A	10	7,5
44	**XP2000**	D	D	10VB	7
44	**PM2202B**	D	D	10	7,4
70	**XP2030**	D	D	10VB	7,2
110	**XP2050**	D	D	10VB	7,5

VB = Venetian blind.

photomultipliers

for medicine

Gamma cameras
Total Body scanners
X-ray scanners

Gamma camera

useful dia. (mm)	type	status	spectral sensitivity characteristic	number of stages	anode pulse amplitude resolution ^{137}Cs (%)	stability (%)
14	**PM1920**	N	S11(A)	6	–	–
14	**PM1910**	D	S11(A)	10	7,6	–
32	**XP2008**	D	SUPER A	10	8	1
32	**PM2012B**	D	D	10	7,2	1
44	**XP2000**	D	D	10VB	7	1
61	**PM2402**	N	D	10VB	7	1
70	**XP2030**	D	D	10VB	7,2	1
110	**XP2050**	D	D	10VB	7,5	1

VB = Venetian blind.

- Gamma cameras, using 19 or 37 photomultiplier tubes of the type XP2000 or XP2030 on one scintillation crystal. Injected radioactive-isotope concentrations *in vivo* result in a scintigram of the part of the body being examined.
- Total Body scanners, for mapping of injected *in vivo* radioactive-isotope concentrations. These scanners use arrays of many photomultiplier tubes, each with a separate scintillation crystal. The detector array - or the patient - is moved in a scan.
- By transmission of X-rays, absorption differences produce a detailed picture of a cross-section of the body (Computer Tomography). Depending on detector configuration tubes like the **PM1910, PM1920 and XP2008** are suitable.

XP2030

laser detection

Common laser wavelengths

HeNe	**632,8 nm**
Kr$^+$	**647,1 nm**
Ruby	**694,3 nm**
YAG	**1064 nm**

See also Fast Vacuum Diodes in the following section Phototubes

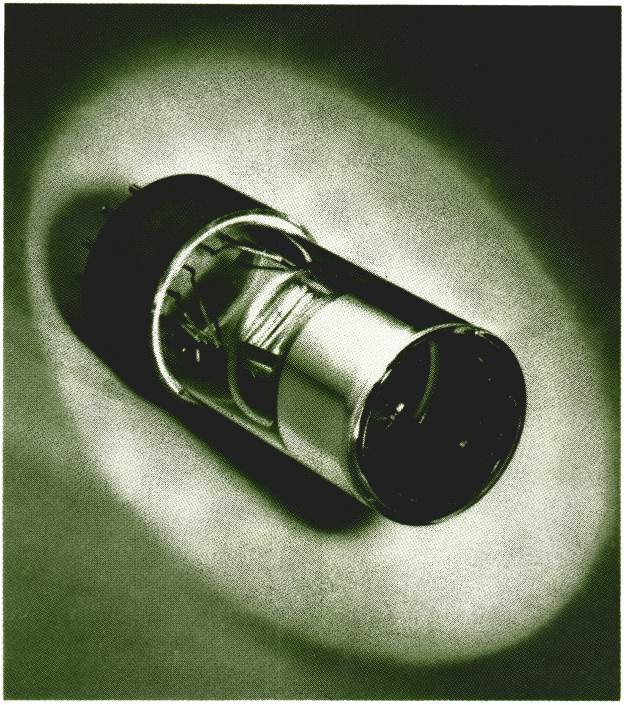
useful diameter (mm)	type	status	spectral sensitivity characteristic	number of stages	photocathode spectral sensitivity N_{kr} (mA/W) at different wavelengths λ (nm) λ = 629	λ = 698	λ = 858	λ = 1060
14	**XP1117**	C	S20(T)	9	23	13		
32	**PM2013B**	D	S20(T)	10	40	20		
44	**56TVP**	M	S20(T)	14	23	15		
44	**XP1002**	D	S20(T)	10	30	16		
32	**XP1017**	D	S20R	10	30	23	6,5	
14	**XP1116**	M	S1(C)	10	(2,0)	(2,3)	2,0	0,12
32	**150CVP**	C	S1(C)	10	(2,1)	(2,3)	1,9	0,12
44	**56CVP**	M	S1(C)	10	(2,0)	(2,3)	1,9	0,10

Scanning techniques

In modern supermarkets the POS-scanner (Point-Of-Sale) enables automatic reading of the Universal Product Code (UPC) by means of an HeNe-laser light beam scanning the code that is preprinted on the product packing. The reflected signal is read by a photomultiplier tube and the digital information contained in the code is fed into the supermarket computer which responds with the correct price and a print out of product name and price for the customer. Tubes used are XP1002 and PM2013B.

Interference techniques

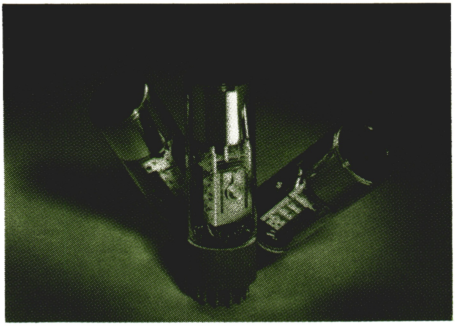
Photomultipliers with trialkaline photocathode spectral sensitivity (S20 and S20R) are commonly used as detectors for light demodulation in laser range-finders.



XP1002

photomultipliers

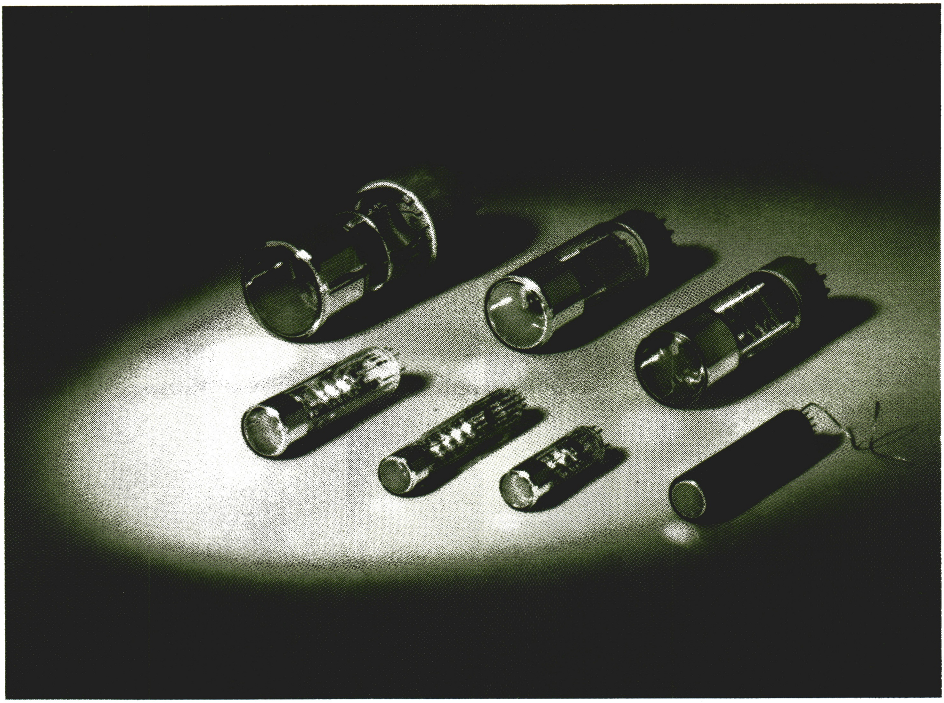
industrial and general purposes



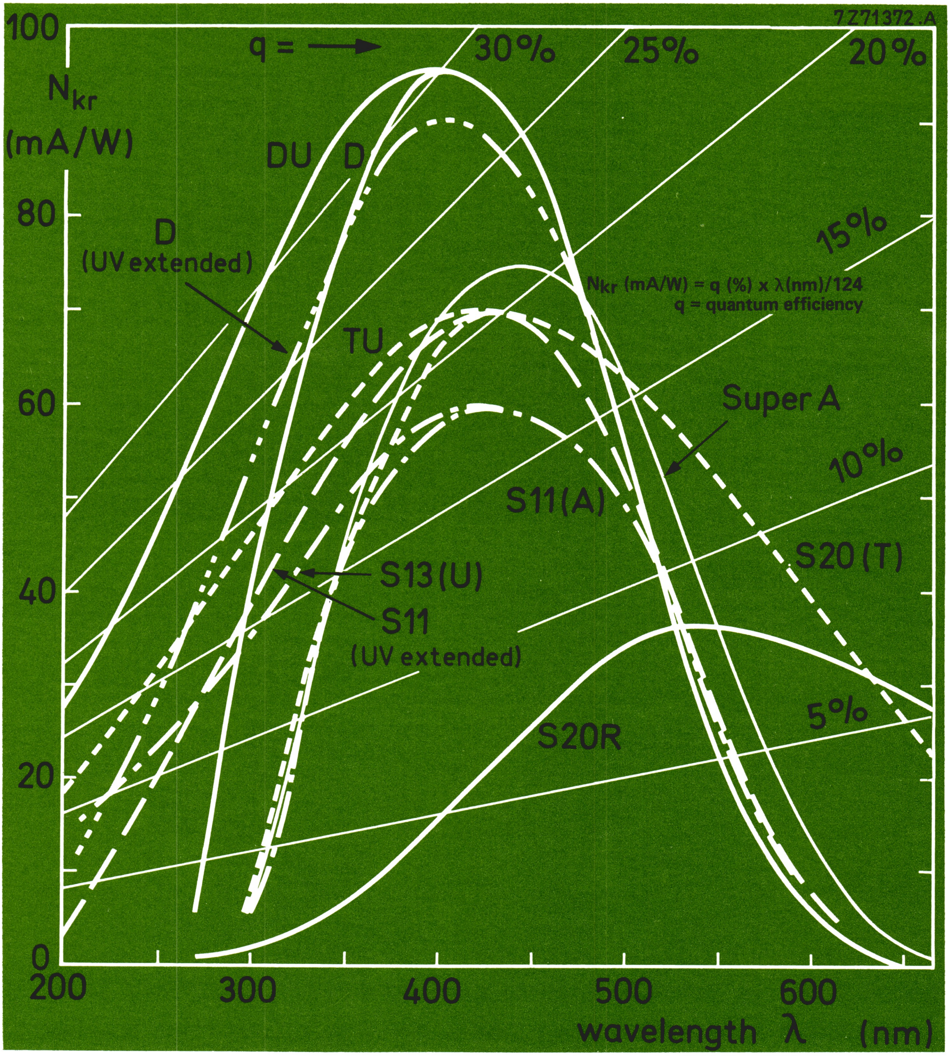
XP2008
PM2012

Types and status

				useful diameter (mm)							
14		23		32		44		61		70	
PM1910	D	**PM1980**	D	**XP2008**	D	**XP1002**	D	**PM2402**	N	**XP2030**	D
PM1920	N	**PM1982**	N	**150CVP**	C	**XP2000**	D				
XP1116	M			**PM2018B**	N	**PM2202B**	D				
XP1117	C			**XP2010**	C						
PM1918	N			**PM2012B**	D						
				PM2060B	D						
				PM2013B	D						
				XP1017	D						

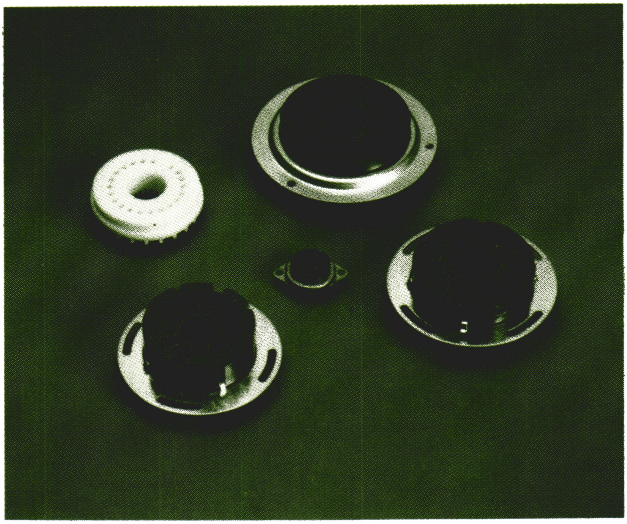


typical photocathode spectral sensitivity



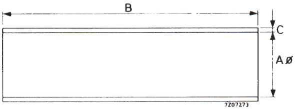
photomultipliers
accessories

Sockets



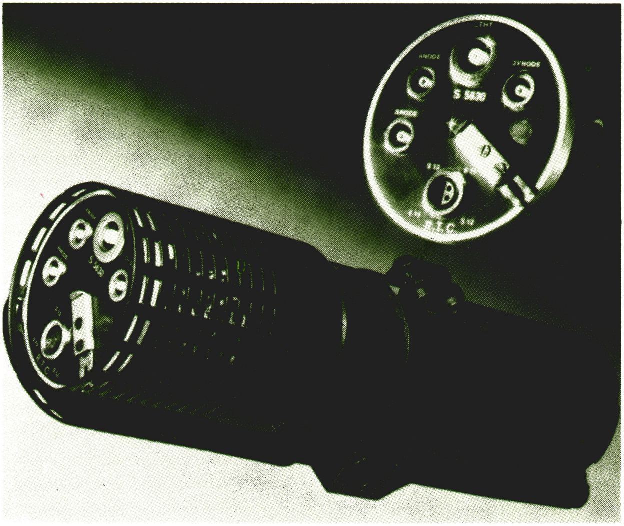
type	status		number of contacts
FE1114	D	diheptal	14
FE1014	D	diheptal	14
FE1012	D	duodecal	12
FE1020	D	bidecal	20
FE1004	D		12
FE2019	D		19
FE2021	D		21

Mu-metal cylindrical shields



type	status	A (mm)	B (mm)	C (mm)
56127	C	42 + 1	90 ± 1	1
56128	C	57 + 1	90 ± 1	1
56129	C	132 + 1	150 ± 1	1
56130	C	57 + 1	110 ± 1	1
56131	C	75 + 1	110 ± 1	1
56132	C	240 + 1	300 ± 1	1
56133	C	145 + 1	250 ± 1	1
56134	C	21 + 1	80 ± 1	1
56135	C	78 + 1	130 ± 1	1
56136	C	28 + 1	110 ± 1	1
56138	C	28 + 1	80 ± 1	1

S5630/ .. base assembly



The S5630/ .. base assembly has been designed for use with fast photomultiplier tubes XP2020, XP2230B, 56-type family, the XP2040, and XP2041.

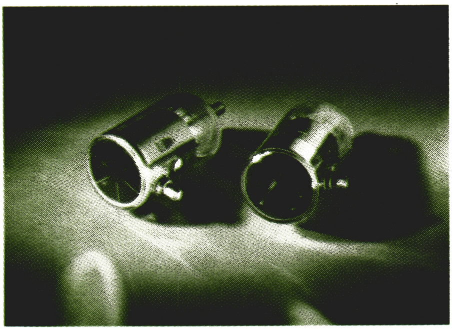
The assembly is intended for the detection of very short light pulses of low intensity and has many applications in experiments in physics, such as those using coincidence techniques, Cerenkov detectors, fast scintillators, or the counting of single photoelectrons.

HT supply for the photomultiplier tube	max. 3000 V
Supply current	max. 1 mA/kV
Available signals on the output terminals	2 anode outputs 1 dynode output

Types

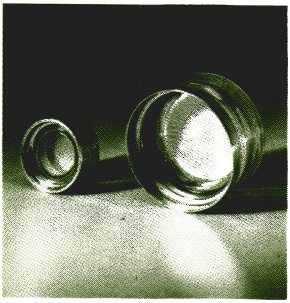
S5630/01	assembly for photomultiplier tubes 56AVP, XP2020Q, 56DVP, 56TUVP, 56TVP, XP2020, XP2230B and PM2232B.
S5630/03	assembly for photomultiplier tubes XP2040, and XP2041.
S5630/01/AR	rear section of assembly only (common for both S5630/01 and S5630/03).

phototubes



Phototubes are photoelectric devices of the emissive type, as distinct from photoconductive cells. They may be devided into three groups:

1. Fast Vacuum Diodes - especially suitable for detection of extremely fast phenomena like picosecond laser pulses. They offer a good linearity for high currents. Special base assemblies are available.
2. Photometry Diodes - used as an alternative to photomultipliers in applications where DC-mode measurements, and large dynamic range, are of interest. They are operated at low voltages and the dark currents could be minimized by the use of an external guard ring.
3. General Purpose Phototubes - mainly useful in simple applications where a "yes/no" answer is sufficient.



Fast Vacuum Diodes

photocathode spectral sensitivity characteristic	useful diameter (mm)	type and status		photocathode spectral sensitivity (mA/W) at	λ(nm)	rise time (ns)	typical anode voltage (kV)
S4	20	**XA1002**	C	35	437	0,2	4
S1(C)	20	**XA1003**	C	2,5	800	0,2	2,5
S20(T)	40	**TVHC40**	C	10	698	0,4	2,5
S4	102	**AVHC201**	C	40	437	1	2,5

Photometry Diodes

photocathode spectral sensitivity characteristic	useful diameter (mm)	type and status		photocathode spectral sensitivity (mA/W) at	λ(nm)
S1(C)	26	**150CV**	C	2,5	800
S20(T)	26	**150TV**	C	13	698
S11(A)	30	**150AV**	C	60	437
S13(U)	30	**150UV**	C	50	437

General Purpose Phototubes

photocathode spectral sensitivity characteristic	useful area (mm x mm)	type and status		luminous sensitivity (μA/lm)
S11(A)	22 x 11	**92AG**	C	130
S11(A)	22 x 11	**92AV**	C	45
S1(C)	22 x 11	**90CG**	C	125
S1(C)	22 x 11	**90CV**	C	20

replacement guide for electron tubes

type to be replaced	replacement
1BQ2	DY802
1S2	DY802
1S2A	DY802
3BH2	GY501
4CM4	PC86
4DL4	PC88
4FY5	PC97
4HA5	PC900
5AR4	GZ34
6AJ8	ECH81
6AL3	EY88
6AQ8	ECC85
6BL8	ECF80
6BM8	ECL82
6BQ5	EL84
6BX6	EF80
6BY7	EF85
6C12	ECH81
6C16	ECF80
6CA7	EL34
6CM4	EC86
6CM5	EL36
6CW5	EL86
6DJ8	ECC88
6DL4	EC88
6DL5	EL95
6DS8	ECH83
6DX8	ECL84
6EC4	EY500A
6EC4A	EY500A
6ED4	ED500
6EH7	EF183
6EJ7	EF184
6ES8	ECC189
6F19	EF85
6F23	EF80
6F26	EF85
6F29	EF183
6F30	EF184
6FC7	ECC89
6GB5	EL504
6GB5A	EL504
6GJ7	ECF801
6GK6	EL84
6GV8	ECL805
6GW8	ECL86
6HA5	EC900
6HG8	ECF86
6HM5	EC900
6JW8	ECF802
6JX8	ECH84
6KG6	EL509
6KG6A	EL509; EL519
6KW6	EL508
6L12	ECC85
6L13	ECC83
6LD6	EL802
6P15	EL84
6R3	EY81
6S2	EY802
6S2A	EY802
6U9	ECF201
6V9	ECH200
6X9	ECF200
6Y9	EFL200
7DJ8	PCC88
7ES8	PCC189
7HG8	PCF86
8GJ7	PCF801
8HG8	PCF86
8U9	PCF201
8X9	PCF200
9A8	PCF80
9AK8	PABC80
9AQ8	PCC85
9ED4	PD500
9JW8	PCF802
9V9	PCH200
10FC12	UBF89
10L14	UCC85
10LD12	UABC80
10P18	UL84
12AC5	UF41
12AT7	ECC81
12AU7	ECC82
12AX7	ECC83
12S7	UAF42
14GW8	PCL86
15A6	PL83
15CW5	PL84
15DQ8	PCL84
16A5	PL82
16A8	PCL82
16LD6	PL802
16Y9	PFL200
17KW6	PL508
17Y9	PFL200
17Z3	PY81
18GV8	PCL805
19FL8	UBF89
19Y3	PY82
21A6	PL81
25E5	PL36
26AQ8	UCC85
27GB5	PL504
27GB5A	PL504
30AE3	PY88
30C1	PCF80
30P4	PL36
30P16	PL82
30P18	PL84
40KG6A	PL509; PL519
42EC4	PY500A
42EC4A	PY500A
45B5	UL84
50BM8	UCL82
64SPT	EF80
121VP	UF41
163Pen	PL82
5751	ECC83
6267	EF86
7189	EL84
8278	EL503
B109	UCC85
B152	ECC81
B309	ECC81
B329	ECC82
B339	ECC83
B719	ECC85
CV455	ECC81
CV491	ECC82
CV492	ECC83
CV593	GZ34
CV1375	EF85
CV1376	EF80
CV1377	GZ34
CV1741	EL34
CV2128	ECH81
CV2901	EF86
CV2940	EL36
CV2966	EY802
CV2975	EL84
CV5077	PL81
CV5094	EL86
CV5215	ECF80
CV5331	ECC189
CV5358	ECC88
DH109	UABC80
DY87	DY802
ECL85	ECL805
EL500	EL504
EL505	EL509 EL519
EY86	EY802
EY87	EY802
EY500	EY500A
HF121	UF41
LN119	UCL82
LN309	PCL82
LZ329	PCF80
M8195	EF86
N119	UL84
N152	PL81
N153	PL83
N154	PL82
N329	PL82
N359	PL81
N369	PCL82
N379	PL84
N709	EL84
PC185	PCL805
PL500	PL504
PL505	PL509; PL519
PY80	PY82
PY500	PY500A
U49	EY802
U153	PY81
U154	PY82
U192	PY82
W142	UF41
W719	EF85
WD119	UBF89
WD142	UAF42
X719	ECH81
Z152	EF80
Z719	EF80
Z729	EF86

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type to be replaced	replacement
1CP31	DH3-91
2B29	(QQE06/40); (5894)
2B32	QQE04/20; 832A
2B46	QE05/40; 6146
2B52	QQE03/20; 6252
2B94	QQE06/40; 5894
2C39BA	7289
2D21	PL2D21; PL5727
2D21W	PL5727
2D21WA	PL5727
2E24	(QV05-10)
2E26	QV05-10
2G57	PL5557
2G402A	DCX4/1000
2V/470C	(DCG4/5000)
2V/471A	(DCG4/5000)
2V/490C	(DCG4/5000)
2V/500C	(DCG4/5000)
2V/530A	(DCG9/20)
2V/530E	(DCG9/20)
2V/531E	(DCG9/20)
3-400Z	(YD1130)
3ALP1	DG7-5
3AMP1A	DG7-32
3BKP31	DH7-11
3BYP31	DH7-11
3C800C	TB5/2500
3CX100A5	7289
3E29	QQV5-P10
3F65	QB3/200
3V/390A	PL5599
3V/490A	(PL105)
3V/531E	(DCG12/30)
4-65A	QB3/200
4-125A	QB3/300GA
4-250A	QB3.5/750GA
4-400A	QB4/1100GA; YL1461
4B13	QB2/250
4CX250B	QEL2/275
4CX250F	QEL2/275H
4CX250FG	8621
4CX250R	7580W
4CX350A	YL1340; 8321
4CX350F	YL1341;8322
4D21	QB3/300GA; 4-125A
4F15R	QEL1/150; 4X150A
4F20R	4X150D
4F21	QB3/300; 6155
4G/280K	PL2D21; PL5727
4H/135M	QEL1/150; 4X150A
4H/136M	QEL1/150; 4X150D
4H/160M	QEL2/275; 4X250B
4J	QQE06/40; 5894
4KM50000LA	(YK1000)
4KM50000LA3	(YK1000)
4KM50000LF	(YK1004)
4X150A	QEL1/150
4X150D	QEL1/150H
4X250B	QEL2/275
4X500A	QBL4/800
5C/100A	QB2/250; 813
5D22	QB3.5/750GA; 4-250A
5F20RA	QEL2/275
5F22	QB3.5/750GA
5F23	QB4/1100GA
5T33	(TB4/1250; 5868)
6AQ4	EC91
6AS6W	5725
6F50R	QBL4/800; 4X500A
6Q4	EC80
6R4	EC81
6T40	TB4/1500
6T50	TB5/2500
6T51	(TB5/2500)
6T61R	(TB4/1250)
6T66R	(TB4/1500)
7T54RA	(TBL6/14)
7T62R	(TB5/2500)
11E13	QQE03/12; 6360
20A2	PL6574
20A3	PL2D21; PL5727
20PE11	XQ1270
20PE13	XQ1271
20PE14	XQ1272
20PE19	XQ1272
20PE20	XQ1272
21A1	PL6574
25PE14	(XQ1400); (XQ1401); XQ1402)
43QV26	(XQ1240)
43QV26/P	(XQ1241)
43QV26/R	(XQ1241)
43QV26/T	(XQ1240); (XQ1241)
45BA6	367
52QV26	(XQ1240): (XQ1280)
55QV26	(XQ1241)
57	PL5559
63QV26	(XQ1240)
63QV26/P	(XQ1241)
100R	8020
105A	PL105

type to be replaced	replacement
172	(PL105)
272	PL5557
287A	PL5557
309	PL5557
500D0058	F23XX
502A	(PL2D21); (PL5727)
575A	(DCG6/18GB)
631	PL5559
651	ZX1052
652	ZX1051
655	ZX1053; (ZX1063)
656	ZX1052
657	ZX1051
673	(DCG6/18)
676	(PL105)
682	ZX1060
686	ZX1060
710	PL5684/C3JA
715	PL5557
807	QE06/50
813	QB2/250
829B	(QQE06/40); (5894)
832	QQE04/40; 832A
832A	QQE04/20
833A	(TB4/1250)
857B	(DCG7/100B)
869	(DCG9/20)
869A	(DCG9/20)
872A	ZY1000
873	(DCG6/6000)
884	(PL2D21); (PL5727)
885	(PL2D21); (PL5727)
967	PL5557
1170	(XQ1270); (XQ1271)
1171	(XQ1270); (XQ1271)
1172	(XQ1270); (XQ1271)
1173	(XQ1270); (XQ1271)
1180	(XQ1270); (XQ1271)
1181	(XQ1270); (XQ1271)
1182	(XQ1270); (XQ1271)
1183	(XQ1270); (XQ1271)
1191	(XQ1270); (XQ1271)
1192	(XQ1270); (XQ1271)
1193	(XQ1270); (XQ1271)
1255FIM	(XQ1031)
1255NOR	(XQ1031)
1255IND	(XQ1032)
1707	PL5557
2100A	8020
2255FI	(XQ1285)

type to be replaced	replacement
2255FIM, NOR	(XQ1240)
2255 IND,BAE,ENT	(XQ1241)
2255ROE	(XQ1240); (XQ1280)
2260	(XQ1285)
2260FIM,NOR	XQ1240
2260 IND,BAE,ENT	XQ1241
2260ROE	XQ1240;XQ1280
2800	XX1306
3101	(XQ1400)
3102	(XQ1401)
3103	(XQ1402)
3300	(XQ1070)
3301	(XQ1070)
3302	(XQ1071)
3303	(XQ1071)
3350	(XQ1072)
3861B	QEL1/150;4X150A
3874A	QB2/250;813
3078A	(DCG9/20)
3885A	DCX4/1000
4078A	(DCG9/20)
4078GA	(DCG9/20)
4078Z	(DCG9/20)
4101	(XQ1440)
4101X	(XQ1440)
4102	(XQ1440)
4103	(XQ1440)
4260	PL5557
4261	PL5557
4440	XP1011
4463	(XP1002)
4478	(QX1032)
4501	(XQ1274)
4502	(XQ1274)
4503	(XQ1274)
4507	(XP1230)
4517	(PM2012B);(XP2010)
4522	XP2041
4523	(XP2000)
4524	(XP2030)
4532	(XQ1401)
4532A	(XQ1400)
4532AMR	(XQ1402)
4543	XQ1240
4591L,R,G,B	55875,L,R,G,B
4592L,R,G,B	(XQ1020L,R,G,B)
4593	XQ1023P
4594	XQ1025R

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type to be replaced	replacement
4803	XX1063
4804	S30XQ
4816	(55876/01)
4817	(XQ1022)
4844	XX1306
5121	DCX4/1000
5545	PL5545
5550	ZX1060
5551	ZX1051
5551A	ZX1051
5552	ZX1052
5552A	ZX1052
5553	ZX1053;(ZX1063)
5553A	ZX1053;(ZX1063)
5553B	ZX1053
5557	PL5557
5559	PL5559
5656KS	(XP2000)
5684	PL5684/C3JA
5727	PL5727
5762/7C24	(YD1120)
5763	QE03/10;M8096
5819	(XP2000)
5822A	ZX1061
5861	EC55
5866	TB2.5/300
5867	TB3/750
5868	TB4/1250
5869	(DCG6/6000)
5870	DCG12/30
5894	QQE06/40
5895	QQC04/15
5920	E90CC
5923	TBW6/6000
5924	TBL6/6000
596000	
0824124	XQ1031;XQ1032
800-0602	(XQ1031)
958-0083	XQ1031;XQ1032
5960-17-	
035-0700	XQ1241
5960-99-	
038-0698	XX1063
038-0699	XX1063
038-0717	XX1060/01
038-0732	XX1332
118-1616	XQ1241
6011	PL5684/C3JA
6075	QBW5/3500
6076	QBL5/3500
6077	TBW12/100
6078	TBL12/100
6079	QB5/1750
6083	PE1/100
6084	E80F
6085	E80CC
6086	18042
6096	E95F
6097B	(XP2000)
6097KB	(XP2000)
6097KL	(XP2000)
6097L	(XP1000)
6146	QE05/40
6146A	QE05/40
6146B	YL1370
6155	QB3/300
6156	QB3.5/750
6159	QE05/40H
6159A	QE05/40H
6159B	YL1372
6189	E82CC
6198	(XQ1031);(XQ1032)
6199	PM2060B;(XP2008)
6227	E80L
6252	QQE03/20
6292	(XP2000)
6308	(ZZ1000)
6326	(XQ1031);(XQ1032)
6342A	PM2202B
6342A/V1	PM2202FLB
6346	(ZX1051)
6347	(ZX1052)
6348	(ZX1053)
6360(A)	QQE03/12
6363	(XP2030)
6364	(54AVP)
6414XX	XX1063
6508	DCG9/20
6511	(ZX1061)
6524	(QQE03/20);(6252)
6617	TBW12/25
6618	TBL12/25
6681	E83CC
6686	E81L
6688	E180F
6689	E83F
6693	DCG6/18
6786	DCG7/100B
6810A	(56AVP)
6816	YL1101
6850	(QQE03/20)
6883	QE05/40F
6883A	QE05/40F
6883B	YL1371
6884	YL1100
6894	(DCG6/18GB)
6895	(DCG6/18)
6903	(XP1004)
6922	E88CC
6923	EA52
6939	QQE02/5
6960	TBW7/8000
6961	TBL7/8000
6977	DM160
7004	TBL2/300
7014XX	XX1306
7034	QEL1/150;4X150A
7035	QEL1/150H;4X150D
7038	(XQ1031)
7062	E180CC
7064	(XP2000)
7065	(XP2008)
7092	TB5/2500
7102	150CVP
7114XX	XX1332
7119	E182CC
7136	DCG6/18GB
7203	QEL2/275;4CX250B
7204	QEL2/275H;4CX250F
7213	YL1280
7226	(XQ1031);(XQ1032)
7237	(TBL7/8000);(6961)
7262A	XQ1031;XQ1032
7265	(56TVP)
7290	XQ1280
7291	(XQ1031)
7308	E188CC
7320	E84L
7325	(XQ1031);(XQ1032)
7377	QQE04/5
7378	QE08/200
7459	(YD1120)
7527	YL1460
7534	E130L
7580	QEL2/200
7580W	YL1170
7643	E80CF
7645	(QQE02/5);(6939)
7650	YL1110
7696	XP2000

type to be replaced	replacement	type to be replaced	replacement	type to be replaced	replacement
7704	QBL5/4000	8429	YL1120	8734	YD1173
7721	D3a	8436	EC158	8735	YD1182
7722	E280F	8438	QB41100GA;YL1461	8736	YD1192
7735	(XQ1032)	8438A	YL1461	8744	YL1330
7735A	(XQ1031);(XQ1032)	8457	YL1210	8752	YD1202
7735B	(XQ1031)	8458	YL1240	8801	YD1180
7737	E186F	8463	YL1000	8812	YL1420
7753	TBL6/4000	8482	ZT1001	8813	YL1430
7767	PM1910	8484	(XQ1031)	8814	YL1440
7788	E810F	8485	(XQ1240)	8844	(XQ1271)
7800	(TBL12/40)	8505	YL1250	8867	YD1352S
7804	TBL6/14	8507	(XQ1241)	8888	YL1470
7805	TBW6/14	8507A	(XQ1240)	8913	YD1195
7806	TBL12/38	8541	XQ1241	8915	YL1520
7807	TBW12/38	8541A	XQ1240	8918	YD1342
7836	QE08/200H	8552	YL1371	8929	(XQ1272)
7854	YL1060	8560	YL1320	8935	YD1185
7983	QQC03/14	8566	XQ1240	8936	YD1187
7986	TB2.5/400	8572	(XQ1240);(XQ1241)	8937	YD1197
8008A	ZY1001	8572A	XQ1240	8952	YD1175
8032	QE05/40K	8575	XP2230	8958	YD1177
8032A	YL1371	8577	YL1220	9514B	(XP2230)
8042	QC05/35	8579	YL1150	9514S	(XP2230)
8053	XP2000	8580	YL1190	9524B	PM1982
8054	XP2030	8585/V1	XX1050	9526B	(150UVP)
8055	XP2050	8585/V2	XX1050	9530B	(54AVP)
8063	PL5684/C3JA	8586	XX1060/01	9558B	(XP1002)
8078	TB4/1500	8591	TBH6/14	9558F	(XP1002)
8116	YL1071	8592	TBH7/8000	9558QB	(XP1003)
8117A	YL1070	8593	TBH7/9000	9594B	(XP2020)
8118	YL1020	8594	TBH12/38	9596B	(XP1002)
8119	TBL2/400	8603	YL1310	9597B	(56TVP)
8120	TBL2/500	8604	XQ1240	9597QB	(56TUVP)
8163	YD1130	8610	THB6/6000	9620	XQ1241
8165	QB3/200	8625	(XQ1240)	9635B	(XP2230)
8177	QBL3.5/2000	8626	XQ1240	9635QB	(56DUVP)
8179	QB5/2000	8637	YL1300	9656F	(XP2000)
8223	E288CC	8644	XP1117	9656KB	XP2000
8228	ZZ1000	8654	YL1230	9656KL	XP2000
8233	E55L	8666	YD1170	9656KQB	XP1004
8254	EC1000	8667	YD1171	9656KR	XP2000
8255	E88C	8668	YD1172	9656QB	(XP1004)
8268	TBW7/9000	8680	YD1212	9658F	(XP1002)
8269	TBL7/9000	8683	YL1360	9684B	(56CVP)
8270	ZT1000	8728	YD1150	9677F1,F2	XQ1240
8298A	YL1370;6146B	8729	YD1151	9677M,P	XQ1241
8321	YL1340	8730	YD1152	9677S1,S2,SC	XQ1240
8322	YL1341	8731	YD1160	9698B	(XP1117)
8348	YL1080	8732	YD1161	9708B	(XP2030)
8408	YL1130	8733	YD1162	9709B	(54AVP)

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type to be replaced	replacement	type to be replaced	replacement	type to be replaced	replacement
9734B	PM1982	AG5005	(DCG7/100)	AX9901	TB3/750;5867
9734QB	(150UVP)	AG5006	(DCG6/18)	AX9902	TB4/1250;5868
9758B	(XP2030)	AGR9950	(DCG6/6000)	AX9903	QQE06/40;5894
9813B	(XP2020)	AGR9951	(DCG6/6000)	AX9904	TBW6/6000;5923
9814B	(XP2020)	AH213	(DCG9/20)	AX9904R	TBL6/6000;5924
9812PA	XQ1241	AH221	(DCG4/5000)	AX9905	QQC04/15;5895
9815B	(XP2020)	AH238	(DCG4/5000)	AX9906	TBW12/100;6077
9817PA	XQ1240	AJ5547	(ZX1052)	AX9906R	TBL12/100;6078
9820QB	(XP1230Q)	AJ5551	ZX1051	AX9907	QBW5/3500;6075
9734B	PM1982	AJ5551A	ZX1051	AX9907R	QBL5/3500;6076
9750KB	XP2000	AJ5552	ZX1052	AX9908	QB5/1750;6079
9757B	(XP2000)	AJ5552A	ZX1062	AX9909	PE1/100;6083
9758KB	(XP2030)	AJ5553A	ZX1053	AX9910	QQE03/20;6252
9791KB	(XP2050)	AJ5553B	ZX1053,(ZX1063)	B1135	TB3/750;5867
9810KB	56AVP	AJ6346	(ZX1051)	B1152	TB4/1500
9811KB	(50AVP)	AR10	(ZX1052)	B1153	TB5/2500
9812KB	XP1000	AR10T	(ZX1052)	BK24	ZX1052
9813KB	56DVP	AR10TP	(ZX1052)	BK24A	(ZX1052)
9813KQB	56DUVP	AR10TWS	(ZX1052)	BK24B	(ZX1052)
9814B	PM2202;PM2232	AR14	ZX1051	BK24C	ZX1052
9814KB	(XP2230B)	AR14T	(ZX1051)	BK34	ZX1063
9816KB	56TVP	AR14TP	(ZX1051)	BK34A	(ZX1063)
9816KQB	56TUVP	AR14TWS	(ZX1051)	BK34B	(ZX1063)
9817KB	(56TVP)	ASG5007	(DCG12/30)	BK42	ZX1051
9820B	(XP1230)	ASG5017	PL5557	BK42A	ZX1051
9821B	PM2312	ASG5045B	PL106	BK42B	(ZX1051)
9824B	(PM1980)	ASG5121	PL2D21;PL5727	BK42C	ZX1051
9825B	PM1912	ASG5155A	(PL255)	BK66	(ZX1060)
9826	PM1912	ASG5545	PL5545	BK146	ZX1053;ZX1063
9826B	PM1912	ASG5727	PL5727	BK168	(ZX1061)
9855	XP2040	ASG5830	(DCG7/100)	BK168B	(ZX1061)
9856	PM2202	ASG6011	PL5684/C3JA	BK542	ZX1061
10067B,F,G,SC	(XQ1031)	ASG6574	PL6574	BT5	PL5559
10667M,S	(XQ1032)	ATS25	QE06/50;807	BT17	(PL105)
18042	6086	AX4-125A	QB3/300;6155	BT19	(PL5557)
55850F,S,SR	(XQ1031)	AX4-250A	QB3.5/750;6156	BT29	PL255
55850N,AM	(XQ1032)	AX105	PL105	BT91	PL5544
55851F,S	XQ1240	AX224	DCX4/1000	BR191B	YD1120
55851SR	XQ1240;XQ1280	AX228	(DCX4/5000)	BR1126	YD1230
55851N,AM	XQ1241	AX230	DCX4/5000	BR1160	YD1120
55852F,S	(XQ1240)	AX5551	ZX1051	BR1162	TBL7/8000
55852N,AM	(XQ1241)	AX5551A	ZX1051	BR1165	TBL6/6000
55875L,R,G,B	55875L,R,G,B	AX5552	ZX1052	BR1181	(YD1175)
56000	8020	AX5552A	ZX1052	BR1182	(YD1185)
A4051	QE06/50;807	AX5553	ZX1053	BR1196	YD1160
ACS4	QBL5/3500;6076	AX5553B	ZX1053	BTW6-3	(TBW6/14)
ACT70	YD1120	AX5822	ZX1061	BW1162	TBW7/8000
ACT100	(TBL6/14);(7804)	AX5822A	ZX1061	BW1162J3	TBH7/8000
AG575A	(DCG6/18IGB)	AX7585	ZX1052	BW1165	TBW6/6000
AG869B	(DCG9/20)	AX9900	TB2.5/300;5866	BW1165J3	TBH6/6000

type to be replaced	replacement
BW1181J3	(YD1177)
BW1182J3	(YD1187)
BW1184J2	(YD1197)
BW1185J2	YD1212
BW1196	YD1161
BW1196J3	YD1162
C932	(XQ1031);(XQ1032)
C933	(XQ1031)
C3JA	PL5684/C3JA
C144	(QQE06/40);(5894)
C178A	QQE06/40;5894
C180	QQE04/120;832A
C1108	QB3/300;6155
C1112	QB3.5/750;6156
C1134	QQE03/20;6252
C1136	QB4/1100;YL1460;7527
C7151W	(XP1017)
C31000A	(56TVP)
C33031DPI	XX1306
C33004	XX1050
C33004A	XX1050
C33095PI	XX1060/01
C70007A	(56CVP)
C70102B	(XP1116)
CCa	(E88CC)
CE305	(PL5557)
CE308	(PL105)
CE309	PL5557
CE311	PL3C23A
CK5654	E95F
CK5725	5725
CQIO.3-1	QEL2/275
CR1100	QBL5/3500;6076
CST2/12	(PL255)
CT1/2500	PL5559
CV5	(DCG4/5000)
CV26	QB2/250;813
CV124	QE06/50;807
CV152	DCG4/5000
CV273	TD03-10
CV309	QE04/10
CV417	EC91;6AQ4
CV424	QQE06/40;5894
CV483	QE04/10
CV635	(TB4/1250);(5868)
CV788	QQE04/20;832A
CV797	PL2D21;PL5727
CV1350	TB3/750;5867
CV1351	TB4/1250;5868
CV1510	QE04/10
CV1572	QE06/50;807
CV1629	DCG4/5000
CV1835	DCX4/1000
CV1838	QQC04/15;5895
CV1865	EC81
CV1886	EC80
CV1888	EC81
CV1905	QB3/200;4-65A
CV1924	TB2.5/300;5866
CV2129	M8096;QE03/10;5763
CV2130	QB3/300;6155
CV2131	QB3.5/750;6156
CV2175	DG7-5
CV2210	PL5544
CV2215	PL5545
CV2253	PL6574
CV2295	QQV5-P10;3E29
CV2302	DH3-91
CV2466	QQE02/5;6939
CV2487	QEL2/275;4CX250B
CV2492	E88CC
CV2518	DCX4/5000
CV2519	QEL1/150;4X150A
CV2666	(QQE06/40);(5894)
CV2729	E80F
CV2753	PL5684/C3JA
CV2797	QQE06/40;5894
CV2798	QQE03/12;(6360)
CV2799	QQE03/20;6252
CV2876	PL5727
CV2957	PL5557
CV2963	QB3.5/300GA;4-125A
CV2964	QB3.5/750GA;4-250A
CV2967	8020
CV3522	QB5/1750;6079
CV3523	QE05/40;6146
CV3599	QQV5-P10;3E29
CV3611	5586
CV3879	QB4/1100GA;4-400A
CV3926	TBL6/6000;5924
CV3990	QV05-10;2E26
CV3991	4X150D
CV3998	E180F;E186F
CV4003	E82CC
CV4010	E95F
CV4011	5725
CV4018	PL5727
CV4108	E188CC
CV5027	PL5559
CV5140	EA52;6923
CV5171	DP7-5
CV5188	E182CC
CV5214	E90CC
CV5216	E95F
CV5219	QBL5/3500;6076
CV5231	E188CC
CV5234	PL5684/C3JA
CV5269	DG7-6
CV5397	8108
CV6099	6929
CV6240	XX1060/01
CV8884	DH7-11;3BYP31
CW1100	QBW5/3500;6075
DET22	TD03-10
DET22G	EC55;5861
DG7-1	DG7-5;3ALP1
DG7-2	DG7-6
DG7-3	DG7-5;3ALP1
DG7-4	DG7-6
DG7-5	3ALP1
DG7-32	3AMP1A
DH3-91	1CF31
DH7-11	3BYP31
DH7-91	DH7-11
DHM10-93	E10-12GH
DN7-1	DG7-5;3ALP1
DN7-2	DG7-6
DN7-3	DG7-5;3ALP1
DN7-4	DG7-6
DN7-5	DG7-5;3ALP1
DQ5	(DCG6/18)
DQ5B	(DCG6/18GB)
DQ5C	(DCG6/18)
DQ6	(DCG6/20)
DQ7	(DCG7/100B)
DR7-3	DG7-5
DR7-4	DG7-6
DR7-5	DG7-5
DR7-6	DG7-6
DR869B	(DCG9/20)
DX2	DCX4/1000
DX151	YK1010
DX274	QBW5/3500;6075
DX285	YJ1180
DX290	YJ1320
E91N	PL5727
E152A	QB3/300;6155
E250A	QB3.5/750;6156
E1955	PL2D21;PL5727
E5001	(XQ1070);(XQ1440)

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type to be replaced	replacement
E5022	(XQ1427);(XQ1428);(XQ1274)
E5036	(XQ1400)
E5038	(XQ1285)
E5040,R,G,B	(XQ1020,R,G,B)
E5054	(XQ1022)
E5055,R	(XQ1023,R)
E5058	(XQ1400)
E5061	(XQ1274);(XQ1428)
E5062	(XQ1275)
E5063	(XQ1070);(XQ1440)
E5064	(XQ1070);(XQ1440)
E5067	(XQ1275)
E5070	(XQ1241)
E5072	(XQ1274);(XQ1428)
E5073	(XQ1070);(XQ1440)
E5074	(XQ1070);(XQ1440)
E5091	(XQ1070);(XQ1440)
E5092	(XQ1427)
E5093	(XQ1428)
E5095	(XQ1275)
E5100	(XQ1285)
E5134R	(XQ1024R)
E5139A	(XQ1272)
E5153	(XQ1070);(XQ1440)
E5165	(XQ1275)
E5171	(XQ1285);(XQ1442)
E5172	(XQ1274)
E5173	(XQ1070);(XQ1440)
E5174	(XQ1070);(XQ1440)
E5175	(XQ1275)
E5185A	(XQ1272)
E5187	(XQ1272)
E5195A	(XQ1275)
E5250	(XQ1285);(XQ1442)
E5270	(XQ1070);(XQ1440)
E5271	(XQ1070);(XQ1440)
EF575A	DCG6/189B
EL-C3JA	PL5684/C3JA
EN91	PL2D21;PL5727
ES85	(TB2.5/300);(5866)
ES204A	TB3/750;5867
ES833	(TB4/1250);(5868)
ES833A	(TB4/1250);(5868)
ESU103	DCX4/1000
ESU150	(DCG4/5000)
ESU200	(DCG4/5000)
ESU575	(DCG6/18GB)
ESU673	DCG6/18
F672B	DCG9/20
F369A	(DCG9/20)

type to be replaced	replacement
F369B	(DCG9/20)
F869B	DCG9/20
F4700	XX1050
F4706	XX1060/01
F4720	XX1062
F4721	XX1060/01;XX1063
F4747	F23XX
F9475	XX1060/01
FG17	PL5557
FG27A	(PL5559)
FG57	PL5559
FG97	(PL5557)
FG98A	(PL5557)
FG105	PL105
FG172	(PL105)
FG235A	ZX1052
FG258A	ZX1053
FG271	ZX1051
FTL2-1	TBL6/4000
FTL3-2	(TBL7/8000);(6961)
G101dv	DX4/1000
G20/5d	DCG/20
GD85WR	(ZZ1000)
GL2D21	PL2D21;PL5727
GL57	PL5559
GL414	PL5559
GL415	(ZX1060)
GL575A	(DCG6/18GB)
GL673	(DCG6/18)
GL681	ZX1060
GL807	QE06/50;807
GL813	QB2/250;813
GL829B	(QQE06/40);(5894)
GL832A	QQE04/20;832A
GL5550	(ZX1060)
GL5551	ZX1051
GL5551A	ZX1051
GL5552	ZX1052
GL5552A	ZX1052
GL5553A	ZX1053;(ZX1063)
GL5553B	(ZX1053)
GL5557	PL5557
GL5559	PL5559
GL5720	(PL5559)
GL5822	ZX1061
GL5822A	ZX1061
GL5855	(PL255)
GL6011	(PL5684/C3JA)
GL6159	QE05/40H;6159
GL6346	(ZX1051)

type to be replaced	replacement
GL6347	(ZX1052)
GL6348	(ZX1053)
GL7151	(ZX1063)
GL7681	(ZX1053); (ZX1062)
GLE5000/3/12	DCG6/18
GLE20000/2.5/10	DCG9/20
GRG250/3000	PL5557
GTR83X	(ZZ1000)
GU18	(DCG4/5000)
GU20/21	(DCG4/5000)
GU21SP	(DCG4/5000)
GXU1	DCX4/1000
GXU2	DCX4/5000
H8362	(XQ1070/01)
H8397	(XQ1427); (XQ1428)
H8397A	(XQ1427)
H9311	(XQ1428)
HF255	(DCG9/20)
HS200	(XQ1031)
HS201	(XQ1031); (XQ1032)
HT17	PL5557
ITK3-1	YD1152
ITK5-1	YD1162
ITK8-1	YD1172
ITK10-1	(YD1177)
ITK15-1	(YD1187)
ITK30-1	(YD1197)
ITK60-1	(YD1202)
ITK120-1	(YD1212); (YD1342)
ITL3-1	YD1150
ITL5-1	YD1160
ITL8-1	YD1170
ITL10-1	(YD1175)
ITL15-1	(YD1185)
ITL30-1	(YD1195)
ITLS60-1	(YD1203)
ITS120-1	(YD1213); (YD1343)
K211	(YK1110)
K365	(YK1000)
K1295	(XP2000)
K1322	(XP2008)
K1361	(XP2008)
K1390	(XP2030)
K1404	(XP1117)
K1427	(XP1004)
K1428	(XP2000)
K1430	(XP2030)
K1447	(XP1002)
K1500	(XP2000)
K3017	YK1190
K3018	YK1191
K3082	YK1190
K3083	YK1191
K3084	YK1192
KR11000	YK1091
KXR04-200	YK1090
KT8	(QE06/50); (807)
L4261	F23XX
M7075	XQ1271
M542	5586
MC13-16	Q13-110BA
ME1504	PL5559
MI1050	ZX1051
MI1053	ZX1051
MI1100	ZX1052
MI1103	ZX1052
MI1104	ZX1061
MI1200	ZX1053; ZX1063
MI1203	ZX1053; ZX1063
MI1300	(ZX1063)
MI2053A	ZX1051
MI2100A	ZX1052
MI2103A	ZX1052
MI2104A	ZX1061
MI2200A	ZX1053
MI2203A	ZX1053
MK13-16	(Q13-110GU)
ML4-125A	QB3/300GA; 4-125A
ML4-250A	QB3.5/750GA; 4-250A
ML4-400A	QB4/1100GA; 4-400A
ML833A	(TBA/1250); (5868)
ML869A	(DCG9/20)
ML6198	(XQ1031); (XQ1032)
MT17	PL5557
MT57	PL5559
MT105	PL105
MT5544	PL5544
MT5557	PL5557
MT5559	PL5559
MW13-32	MW13-38
MX9648	F23XX
N1-140/08	ZX1052
NL710	PL5559
NL715	PL5557
NL778	(PL106)
NL869B	(DCG9/20)
NL1005	ZX1051
NL1005A	ZX1051
NL1009A	(ZX1062)
NL1009A/P	(ZX1062)

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type to be replaced	replacement
NL1022	ZX1061
NL1022AP	(ZX1061)
NL1031	ZX1051
NL1032	ZX1053
NL1051A	ZX1051
NL1051A/P	ZX1051
NL1052	ZX1052
NL1052A	ZX1052
NL1052A/P	ZX1052
NL1053	ZX1053
NL1053A	ZX1053
NL1081	ZX1061
NL1081P	ZX1061
NL1082	ZX1062
NL1082P	ZX1062
NL5550	(ZX1060)
NL5551	ZX1051
NL5552	ZX1052
NL5553B	ZX1053
NL5553B/P	ZX1053
NL6989/C6J/KL	PL5545
NL-C6JK/Ne	PL5545
NU832	QQE04/20;832A
OT400	(TB4/1250);(5868)
P2-12	QQE04/20;832A
P2-40B	(QQE06/40)(5894)
P810	(XQ1032)
P813	(XQ1031)
P820	(XQ1031)
P826	(XQ1032)
P826/4478	(XQ1032)
P841	(XQ1240)
P841X	(XQ1240);(XQ1280)
P842	XQ1240
P842X	(XQ1240);(XQ1280)
P843	(XQ1240)
P844	XQ1240
P846	(XQ1240)
P847	XQ1240
P848	(XQ1241)
P848D	(XQ1241)
P849	XQ1241
P849D	XQ1241
P862	(XQ1241)
P896	XX1060/01
P8000,L,R,G,B	55875,L,R,G,B
P8000IG,R,G,B	55875IG,R,G,B
P8000X	55876/01
P8001,L,R,G,B	(XQ1020,L,R,G,B)
P8001X	(XQ1022)
P8003	(XQ1023)
P8003F	(XQ1025)
P8005	(XQ1410,L,R,G,B)
P8007	(XQ1413R)
P8007F	(XQ1415R)
P8021	XQ1070,R,G,B
P8021X	XQ1072
P8022	(XQ1070,R,G,B)
P8022X	(XQ1072)
P8023A	XQ1073
P8023F	(XQ1073)
P8024	(XQ1073)
P8024F	(XQ1075)
P8024IG	(XQ1074)
P8073	XX1050
P8076	XX1063
P8130	(XQ1020);(XQ1410);(55875)
P8131	(XQ1020);(XQ1410);(55875)
P8132A	(XQ1413)
P8132F	(XQ1415)
P8133A	(XQ1413)
P8133F	(XQ1415)
P8136	(XQ1520)
P8138	(XQ1525)
P8142	(XQ1070/02)
P8144A	(XQ1073/02)
P8144F	(XQ1075/02)
P8145	(XQ1080);(XQ1500)
P8146A	(XQ1083);(XQ1503)
P8146F	(XQ1085);(XQ1505)
PE06/40E	PE06/40N
PL2D21	PL5727
PL17	PL5557
PL21	PL2D21;PL5727
PL57	PL5559
PL5551	ZX1051
PL5551A	ZX1051
PL5552	ZX1052
PL5552A	ZX1052
PL5553B	ZX1053
PL5822	ZX1061
PL5822A	ZX1061
PL6011	PL5684/C3JA
PL6549	(QB3/200)
PL6755	PL6755A
PM55	XP1002
Q160-1	(QB3/300);(6155)
Q400-1	(QB4/1100);7527
Q450-1	QB4/1100;7527
QB2/250	813

type to be replaced	replacement
QQV02-6	QQE02/5;6939
QQV03-10	QQE03/12;6360
QQV03-20A	QQE03/20;6252
QQV04-15	QQE04/20;832A
QQV04-16	QQE04/5;7377
QQV06-40	(5894)
QQV06-40A	QQE06/40;5894
QQV07-40	(QQE6/40);829B
QQV5-P10	3E29
QQZ03-10	QQC03/14;7983
QQZ03-20	YL1020;8118
QQZ04-15	QQC04/15;5895
QQZ06-40	YL1030
QV03-12	QE03/10;5763
QV04-7	QE04/10
QV06-20	QE05/40;6146
QV06-20B	QE05/40F;6883
QV06-20C	QE05/40H;6159
QV08-100	QE08/200
QV08-100B	YL1290
QV1-150A	QEL1/150
QV1-150D	QEL1/150H;4X150D
QV2-250C	QEL2/275;4CX250B
QY3-65	QB3/200;4-65A
QY3-125	QB3/300;6155
QY3-125B	QB3/300GA;4-125A
QY3-1000A	QBL3.5/2000;8177
QY4-250	QB3.5/750;6156
QY4-250B	QB3.5/750GA;4-250A
QY4-400	QB4/1100;7527
QY4-400B	QB4/1100GA;4-400A
QY4-500A	QBL4/800;4X500A
QY5-500	QB5/1750;6079
QY5-800	QB5/2000;8179
QY5-3000A	QBL5/3500;6076
QY5-3000W	QBW5/3500;6075
QZ06-20	QC05/35;8042
R189	PM2018B
R208	XP1004
R329	XP2230
R375	(XP1003)
R464	(56DVP)
R550	XP1002
R562	(XP1003)
R580	PM2012B;XP2010
R592	PM2013B
R593	PM2013B
R594	XP2030
R632	(XP1116)
R654	PM1910
R750	PM1910
R762	PM1918
R763	(XP1117)
R877	XP2015
R878	XP2000
RG3-1250	DCG4/5000
RG4-3000	DCG6/18
RK807	QE06/50;807
RL17	PL5557
RL21	PL2D21;PL5727
RL57	PL5559
RL16989/Ne	(PL5545)
RR3-250;1835	DCX4/1000
RR3-1250	DCX4/5000
RR3-1250B	DCX4/5000
RS612	(TB2.5/400)
RS613	TB2.5/300;5866
RS614	TB2.5/400
RS630	TB3/750;5867
RS631	TB4/1250;5868
RS685	QB3/300;6155
RS686	QB3.5/750;6156
RS687	QB5/1750;6079
RS1002A	QB4/1100;7527
RS1003	(YL1200)
RS1006B	TB2.5/400
RS1007	QB3/300;6155
RS1009	QQE06/40;5894
RS1011L	(TBL6/20)
RS1011W	(TBW6/20)
RS1012L	YL1181
RS1012V	YL1182
RS1016	TB4/1250;5868
RS1019	QQE03/20;6252
RS1026	TB3/750;5867
RS1029	QQE03/12;6360
RS1036	TB4/1500
RS1041V	YD1012
RS1041W	YD1010
RS1046	TB5/2500;7092
RS1082CL	YL1011
RS1082CV	YL1012
RS1082CW	YL1010
RS2002V	YL1091
RS2002W	YL1090
RS2021L	YD1001
RS2021V	YD1002
RS2021W	YD1000
RS2022CL	(YL1430)
RS2032CL	(YL1470)

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type to be replaced	replacement
RS2041V	(YD1343)
RS3010CJ	(YD1162)
RS3010CL	(YD1160)
RS3025CJ	(YD1177)
RS3025CL	(YD1175)
RS3026CJ	(YD1182)
RS3026CL	(YD1180)
RS3040CJ	(YD1187)
RS3040CL	(YD1185)
RS3060CJ	(YD1197)
RS3060CL	(YD1195)
RS3150CY	(YD1202)
RS3300CV	(YD1343)
RY12-100	8020
S1.5/80dv	PL5545
S15/5d	(DCG12/30)
S15/40	(DCG7/100)
S15/40i	(DCG7/100)
S50XQ	570XQ
S4075	XQ1274
S4076	XQ1440
S4092	XQ1275
S4093	XQ1442
S4113	XQ1276
SAS	(ZX1060)
SBS	ZX1051
SCS	ZX1052
SCS3	ZX1061
SDS	ZX1053;(ZX1063)
SR6	ZZ1000
SR44	ZZ1000
SRS360	TB3/750;5867
SRS361	TB2.5/300;5866
SRS362	TB4/1250;5868
SRS455	QB3/300;6155
SRS456	QB3.5/750;6156
SRS457	QB5/1750;6079
SRS4451	QQE06/40;5894
SRS4452	QQE3/20;6252
Ste1000/2.5/15	PL5559
Ste1300/01/05	PL2D21;PL5727
Ste1500/15/45	(DCG7/100)
Ste2500/6/40	PL105
T130-1	(TB2.5/400)
T300-1	(TB4/1250);(5868)
T350-1	(TB3/750);(5867)
T380-1	TB3/750;5867
T500-1	TB4/1250;5868
TA12/20000K	TAW12/20
TC2/250	TB3/750;5867

type to be replaced	replacement
TC2/3000	TB3/750;5867
TD03-10G	EC55;5861
TD2-300A	TBL2/300;7004
TD2-400A	TBL2/400;8119
TD2-500A	TBL2/500;8120
TFZ103	(PL5544)
TFZ106B	(PL5545)
TG57	(PL5559)
TH302	(YD1300)
TH306	YD1300
TH308	(YD1333)
TH316	(YD1302)
TH326	(YD1302)
TH328	(YD1333)
TH1586	5586
TH5040	(DCG9/20)
TH5090	(DCG6/18GB)
TH5130	(DCG6/18)
TH5521V/B	DCX4/1000
TH6011	PL5557
TH6031	PL5559
TH6050	(PL5559)
TH6120	(PL105)
TH7010	(ZX1060)
TH7020	ZX1051
TH7021	(ZX1051)
TH7023	ZX1051
TH7030	ZX1052;(ZX1063)
TH7031	(ZX1052);(ZX1063)
TH7033	ZX1052;(ZX1063)
TH7034	ZX1061
TH7035	(ZX1062)
TH7036	ZX1062
TH7040	ZX1053
TH7041	(ZX1053)
TH7043	ZX1053
TH9303	XX1063
TH9473	XX1050
TH9475	XX1060/01
TH9540	S58XQ
TQ2	(PL5527)
TQ2/3	(PL6755A)
TQ2/6	(PL106)
TQ2/12	(PL255)
TQ6	(DCG12/30)
TQ7	(DCG7/100)
TT10	QB2/250
TT15	(QQE04/20);(832A)
TT16	QB3/300GA;4-125A
TT16D	QB3/300;6155

type to be replaced	replacement
TT17	PL5557
TT20	QQE03/20;6252
TX2/3	PL5544
TX12-20	(TAL12/20)
TX12-20W	(TAW12/20)
TX920	PL5559
TXM100	PL2D21
TY2-125	TB2.5/300;5866
TY2-150	TB2.5/400
TY3-250	TB3/750;5867
TY4-350	(TB4/1250);(5868)
TY4-400	TB3/750;5867
TY4-400C	TY4-400C;YD1220
TY4-500	TB4/1250;5868
TY5-500	TB4/1500
TY6-12A	TBL6/20
TY6-12W	TBW6/20
TY6-800	TB5/2500;7092
TY6-1250A	TBL6/4000;7753
TY6-3000A	YD1230
TY6-5000A	TBL6/6000;5924
TY6-5000B	YD1120
TY6-5000H	TBH6-6000;8610
TY6-5000W	TBW6/6000;5923
TY7-6000A	TBL7/8000;6961
TY7-6000H	TBH7/8000;8592
TY7-6000W	TBW7/8000;6960
TY8-15A	TBL6/14;7804
TY8-15H	TBH16/14;8591
TY8-15W	TBW6/14;7805
TY8-6000A	TBL7/9000;8269
TY8-6000H	TBH7/9000;8593
TY8-6000W	TBW7/9000;8268
TY12-15A	TBL12/40;7800
TY12-20A	TBL12/38;7806
TY12-20H	TBH12/38;8594
TY12-20W	TBW12/38;7807
TY12-25A	TBL12/25;6618
TY12-25W	TBW12/25;6617
TY12-50A	TBW12/100;6078
TY12-50W	TBW12/100;6677
TY12-120W	YD1010
TY12-250A	TBL12/25;6618
TY74	(PL5557)
TY76	(PL5559)
TY77	(PL5559)
TY78	(PL5559)
TY84	(PL5559)
TY85	(PL105)
TY6030	(PL5559)

type to be replaced	replacement
TY6050	(PL5559)
TY6100	(PL5559)
TY6120	(PL105)
TY6220	(PL5545)
U-25/08	(ZX1060)
U-25/08P	(ZX1060)
U-70/08	(ZX1051)
U-70/08P	(ZX1051)
U-140/08	ZX1052
U-140/08P	ZX1052
U-350/08	ZX1053
U-350/08P	ZX1053
UE967	PL5557
UY807	QE06/50;807
V40	8020
V54	YK1090
V154	YK1091
V1103	QQE03/12;6360
VJ5551	ZX1051
VJ5551A	ZX1051
VJ5552A	ZX1052
VJ5553	ZX1053
VJ5553B	ZX1053
VT39A	(DCG9/20)
VT79	(QE06/50);(807)
VT88	(QQE04/20);(832H)
VT88A	QQE04/20;832A
VT100	QE06/50;807
VT100A	(QE06/50);(807)
VT118	QQE04/20;832A
VT144	QB2/250
VT259	(QQE06/40);(5894)
VT267	8020
VT286	QQE04/20;832A
VT510	QQE04/10
VTP7386	(PL5545)
VX550A	DCX4/1000
VX7400	DCX4/5000
WE17	PL5557
WL2D21	PL2D21;PL5727
WL17	PL5557
WL57	PL5559
WL105	PL105
WL172	(PL105)
WL414	(PL255)
WL502A	PL5727
WL575A	(DCG6/18GB)
WL624	(PL105)
WL631	PL5559
WL632A	(PL5559)

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type to be replaced	replacement
WL676	(PL105)
WL807	PL807
WL813	QB2/250;813
WL864B	(DCG9/20)
WL885	(PL2D21);(PL5727)
WL5550	(ZX1060)
WL5551	ZX1051
WL5551A	ZX1051
WL5552	ZX1052
WL5552A	(ZX1052)
WL5553	ZX1053;(ZX1063)
WL5553A	ZX1053
WL5553B	ZX1053;(ZX1063)
WL5555	ZX1055
WL5555A	(ZX1055)
WL5557	PL5557
WL5559	PL5559
WL5720	(PL5559)
WL5822	ZX1061
WL5822A	(ZX1061)
WT210-0001	PL2D21;PL5727
WT210-0015	PL5727
WT210-0056	PL5559
WT210-0062	PL5557
WT210-0069	PL5557
WT210-0071	ZX1051
WT210-0072	(ZX1052)
WT210-0073	(ZX1053)
WT210-0074	PL105
WT210-0079	PL105
WT272	PL5557
WTT11	PL5559
WTT117	PL5557
WTT118	PL105
XB767A	(PL2D21);(PL5727)
XG1-2500	(PL5559)
XG2-12	PL255
XG2-25	PL260
XG2-500	(PL5557)
XG2-6400	(PL105)
XG5-500	PL5557
XG15-10	DCG7/100B
XG15-12	(DCG7/100B)
XGQ2-6400	PL105
XN3	ZM1080
XQ1001	(XQ1240)
XQ1002	(XQ1240)
XQ1003	(XQ1241)
XQ1004	(XQ1241)
XQ1005	XQ1240;XQ1280
XQ1006	XQ1240
XQ1007	XQ1240;XQ1241
XQ1008	XQ1241
XQ1030	XQ1031;XQ1032
XQ1040	XQ1240
XQ1041	XQ1240;XQ1280
XQ1042	XQ1240
XQ1043	XQ1241
XQ1044	XQ1241
XQ1050	(XQ1240)
XQ1051	(XQ1240);(XQ1280)
XQ1052	(XQ1240)
XQ1053	(XQ1241)
XQ1054	(XQ1241)
XQ1060	(XQ1240);(XQ1280)
XQ1061	(XQ1240)
XQ1062	(XQ1240)
XQ1063	(XQ1241)
XQ1064	(XQ1241)
XQ1065	(XQ1240)
XQ1066	(XQ1285)
XQ1067	(XQ1285)
XQ1180	XQ1280
XQ1181	XQ1280
XQ1200	(XQ1400)
XQ1201	(XQ1401)
XQ1202	(XQ1402)
XQ1205	(XQ1400)
XQ1206	(XQ1401)
XQ1207	(XQ1402)
XQ1220	XQ1230
XQ1250	XQ1400
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XQ1292	XQ1240
XQ1293	XQ1241
XQ1294	XQ1241
XQ1295	XQ1240
XQ1296	XQ1280
XQ1297	XQ1280
XQ1310	XQ1271
XQ1315	XQ1272
XQ1330	S7001
XQ1331	S7002
XQ1332	S7003;S7004
XQ1450 series	(XQ1440)
XQ1460 series	(XQ1274)
XR1-1600	PL5684/C3JA
XR1-1600A	PL5684/C3JA
XR1-3200	PL5544
YD1331	YD1333
ZT1011	PL5684/C3JA

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